

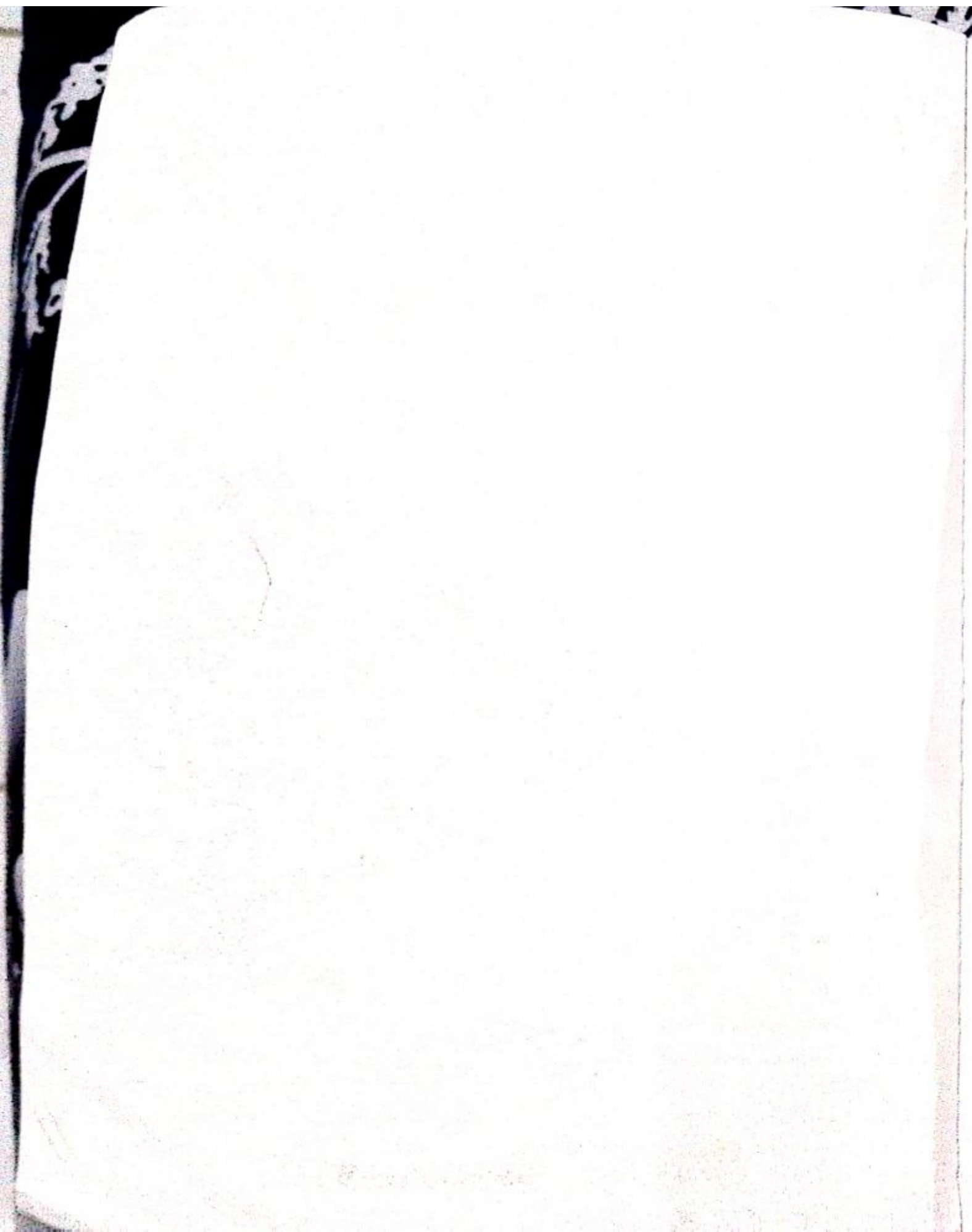
Revised & Updated Edition

8

GENERAL SCIENCE

**Teacher's
Guide Also
Available**

Seema Zahid
Shabana Ahmed



**Al-
Gaba**

Revised & Updated Edition

8

• GENERAL SCIENCE



Seema Zahid
Shabana Ahmed

**Al-
Gaba**

EDUCATIONAL PUBLISHERS

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About the Book

WHAT DOES GENERAL SCIENCE CONSIST OF?

Textbooks

A skill based set of books that emphasize thinking, experimental and application skills, and are far ahead in developing a scientific temper.

Teacher's Guides

No course is complete without a teacher's guide. This teacher's guide is an adaptable resource to support teachers. It gives the course a justifiable sense of completeness. It also contains an exhaustive answer key to the exercises and tasks given in the text book.

Webnet

Has more worksheets and interesting science-based information and activities.

Structure of the Book



The book is divided into 15 units.



There are 4 sets of tasks for formative assessment after every 3 or 4 units.



There are 2 test papers for summative assessment dividing the course into 2 terms as per the standard examination pattern.

The units are divided into sub topics that follow "from known to unknown" approach.

Structure of Each Unit

The text meets the international standard. The explanation of concept is supported by coloured pictures, diagrams and tables.

- Learning Objectives
- Key Points
- Key Words
- Home Assignment
- Teacher's Corner
- Let's work in team
- Test Your Knowledge
- Fun With Science

Exercises for Formative and Summative Assessment

- Short answer questions
- Long answer questions
- Diagram labelling
- Multiple choice questions
- Group activity

Preface

The first edition of this series appeared in 1995 and it is indeed a matter of great satisfaction that for the past fifteen years, the series has been warmly received by both teachers and students and for that, we feel greatly indebted. When the first edition of this series appeared, we aimed to make a small contribution in science education of our country by providing scientific knowledge of international standard to our local students. Never in our wildest dreams did we imagine that we would receive such a tremendous appreciation and encouragement from academic community. In the first edition of our book, we began with the premise that the scientific knowledge at the end of the 20th century was very different from what it had been fifteen years ago. That premise is even more relevant today and worth repeating. Today's scientific scenario is completely different from past. Today, computer dominates the education. Means of communication have been drastically transformed through the exponential growth of the World Wide Web and social media. The admirable advances in the field of science and technology have transformed our lives in a number of ways. This is quite evident in almost every facet of human endeavor, including health, transportation, communication, agriculture, engineering, upper space expeditions and so on so forth. This extreme progress in science and technology has been a key driving force that prompted our team to revise this series. We may also mention here that my own research interests are in the area of using effective instructional strategies and materials for science education in classrooms. Teaching and learning strategies especially in the domain of science have been revolutionised. New instructional strategies and use of more efficient instructional materials have been devised to cope with varying learning styles of students and to equip students with the skills of scientific way of thinking, understanding and processes. While teaching this series, we, ourselves, have felt the necessity of rewriting and/or revising certain parts of these books. Thus, while preparing the present revised edition of this series, extensive reviews and additions have been made. The revised edition incorporates a great deal of modification and includes new materials to meet the requirement of the current syllabus prescribed by the Ministry of Education, Government of Pakistan. This new text includes updated information as well as additional chapters on environment and earth sciences. These chapters have been included in accordance with the most authentic academic researches that verify that these are the most interesting and active areas of science that arouse curiosity and critical thinking in learners to investigate the natural phenomena of science.

As human beings continue to have significant impacts on the environment and its resources, education seems to be the best tool for providing the public with an understanding of the consequences of their actions and behavior patterns in order to increase sensitivity and concern regarding environmental issues. The main goals of learning are to acquire knowledge and gain skills such as problem solving, consensus building, information management, communication, and critical and creative thinking. Environmental issues offer excellent vehicles for developing and exercising

because the earth is constantly changing due to tectonic movement, climatic changes and natural disasters. Being able to monitor the earth's geological activities can help people prepare themselves for natural calamities such as earthquakes and volcanic eruptions.

Gaba General Science encourages pupils to learn actively and attempts to develop in them mental habits and attitudes necessary for the constructive scientific inquiry. It helps pupils grasp scientific concepts and acquire scientific processing and thinking skills through the use of:

- context and experiences of everyday life.
- clear and informative text which is accompanied by annotated diagrams to facilitate understanding.
- interesting facts and topic-related activities to stimulate interest in science.
- thought-provoking questions to encourage critical thinking and analysis.

In this revised edition, we present an integrated approach to physical sciences-biology, ecology, geology, air and water resources--and to human body systems. Science is not an abstract activity performed by flawless gods. At a number of places, boxes have been inserted which, for example, may refer to an illuminating historical development or point at an existing controversy. This has been done in an effort to indicate what difficulties the study of science involves and that a scientific insight is often a result of a long struggle and it is not obtained as a fixed eternal value. We adopt a thoughtful but cautiously optimistic view that will encourage readers to look for ways that can solve problems and make our world a better place to live.

The World Wide Web has become a vast and valuable resource for students. You can find a wealth of information there to update or supplement topics included in this series. Every chapter has a list of web-based resources that enrich the chapter contents. A collection of **key points** is provided in each chapter to aid pupils in revision and self assessment. For an easy reference, an index has been included for each book. S.I. units are used throughout the series. Throughout this series, students are encouraged to practise thinking by themselves. **Fun with science** section provides out of class activities for students to engage them in the subject and to encourage them to practice their factual knowledge. Three model assessment papers have been provided to help students understand the pattern of assessment.

We are thankful to our publisher, Gaba Educational Books for involving us in this project, Roomana Asmeen, our language editor, and especially to Mr. Ashraf Hussain, the graphic designer of this book. Finally, we need to thank our critiques. Every text owes a great deal to those faculties across the country who study it and suggest suitable substitution and additions. Serving as sensitive antennae for errors and advisors for new approaches, reviewers are among the most valuable tools which are at an author's disposal. Representing a very diverse array of institutions and interests, they have provided us with invaluable feedback. Many new features and improvements in this edition are the direct result of their suggestions. We hereby, pay our sincere gratitude to them. We shall be very grateful to receive suggestions for further improvement of this series. For discussions and suggestions, please visit our website: www.gabaedu.com

Authors

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PLANNING A LEARNING SEQUENCE

Planning for Teaching and Learning is a fundamental requirement for the development, implementation and success of a curriculum. Lesson planning is carried out to ensure that our children are enabled to progress at their best pace within the curricular framework. The weekly plan is made to ensure effective day to day teaching whereas formative assessment is a tool to enhance future learning. It will show how specific objectives, related to each lesson will be achieved by individuals and small groups and how key skills will be developed in learners. The specific needs of the individual, previous learning experiences, and available and needed resources will be considered in the weekly planning. The weekly plan identifies the knowledge and skills students have to acquire and provides systematic opportunities to learn and a comprehensive assessment plan at the end of each term.

For the timely completion of the syllabus and achievement of all the planned learning objectives, a workable scheme has been formulated. On the basis of this scheme and keeping academic calendar of a school in mind, a weekly plan has been proposed here. This is only a suggested planner. Feel free to make changes in it to suit your class and school needs.

A Workable Scheme

05 periods in a week
 $\times 4$ weeks in a month
 20 periods in a month
 $\times 9.5$ months in a year
 190 periods in a year

An Academic Calendar

365 days in a year
 - 60 days of summer vacations
 305
 - 10 days of winter break
 295
 - 90 days of Megazothedistrict and local holidays
 205
 - 15 days of school events
 190
 - 20 days for three term examinations
 170 left over school days

WEEKLY LESSON PLAN

First Term

WEEKS	UNITS / TOPICS	PRACTICAL ACTIVITIES
Weeks 1-3	01 Sustenance of the Individual (Nutrition and Respiration)	- To test a leaf for the presence of starch. - To verify that light is necessary for photosynthesis. - To check the effect of saliva on starch.
Weeks 4-6	02 Sustenance of the Individual (Transport)	- To show osmosis through Semipermeable membrane. - To observe the internal structures of dicot stem and root. - To study the internal structure of a mammalian kidney.
Weeks 7-9	07 Communication in Chemistry (Symbols, Formulae and Equations)	- To observe different features of chemical reactions. - To carry out different chemical reactions and differentiate them as exo or endothermic. - To carry out neutralization reactions.
Weeks 10-12	10 Synthetic Materials and Chemical Industries 11 Force and Pressure	- To prepare soap. - To show that liquids exert pressure in all directions. - To show buoyancy in water.
Week 13	FIRST TERM EXAMINATION	

Second Term

WEEKS	UNITS / TOPICS	PRACTICAL ACTIVITIES
Weeks 14-16	06 The Living Environment 08 Acids Bases and Salts	- To observe biotic and abiotic components in a pond. - To study working of different indicators in different acidic and basic solutions. - To observe action of acids and different metals.
Weeks 17-19	12 The Current Electricity	- To study the working of an electroscopes. - To study parts of a dry cell. - To verify the phenomenon of electromagnetic induction.
Weeks 20-21	09 Carbon and its Compounds	- To prepare wood charcoal. - To prepare carbon dioxide gas. - To study and learn the working of a fire extinguisher.
Weeks 22-24	03 Control and Coordination	- To study the parts of the human brain with the help of model. - To verify that stem grows towards gravity. - To show Phototropism in plants.
Week 25	SECOND TERM EXAMINATION	

Third Term

WEEKS	UNITS / TOPICS	PRACTICAL ACTIVITIES
Weeks 26- 28	04 Reproduction and Growth 05 Continuity of Life and Variations	- To observe budding in yeast. - To observe spores under a microscope. - To study parts of a flower.
Weeks 29-30	13 Light and its Behavior	- To verify refraction of light in water. - To show dispersion of light through a prism. - To calculate the focal length of a convex lens.
Weeks 31-33	14 Magnet and Magnetism	- To show the attraction and repulsion between poles of two magnets. - To show magnetic lines of force. - To study the parts of a microphone.
Weeks 34-36	15 The Earth and Space	- To observe the process of rusting in iron. - To understand the expansion of the universe. - To study the properties of different alloys.
Week 37	REVISION THIRD TERM EXAMINATION	

WEBNET

(RESOURCES TO ENHANCE LEARNING AND KNOWLEDGE FROM THE INTERNET)

1. Sustenance of the Individual (Nutrition and Respiration)

<http://encyclopedia.kids.net.au/page/re/Respiration>
<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/Nutrition>
http://www.lung.ca/children/grades7_12/respiratory/respiratory_system.html

2. Sustenance of the Individual (Transport)

http://www.biology4kids.com/files/plants_xylemphloem.html
http://keywen.com/en/Kids_and_Teens/School_Time/Science/Living_Things/Animals/Mammals/Humans/Circulatory_System/LYMPHATIC_SYSTEM
<http://www.factmonster.com/ipka/A0774536.html>

3. Control and Coordination

<http://manojsirscience4u.blogspot.com/2007/06/control-and-coordination-in-living.html>
<http://www.tutorvista.com/content/biology/biology-iii/control-and-coordination/control-and-coordination-animals.php>
<http://www.education.kerala.gov.in/englishmedium/bioeng/chapter3>

4. Reproduction and Growth

<http://www.buzzle.com/articles/characteristics-of-living-things.html>
<http://www.kidsbutterfly.org/life-cycle%20%20>

5. Continuity of Life and Variations

<http://www.exploringnature.org/db/detail.php?dbID=22&detID=53>
<http://www.solonschools.org/accounts/NBarnes/Geneticsnotes.doc>
<http://learn.genetics.utah.edu/content/begin/tour/>
<http://learn.genetics.utah.edu/content/begin/tour/>

6. The Living Environment

<http://dnr.wi.gov/eeek/>
<http://www.epa.gov/kids/>
<http://www.earthmatters4kids.org/>
<http://www.epa.gov/epahome/students.htm>
<http://kids.nceas.ucsb.edu/>

7. Communication in Chemistry (Symbols, Formulae and Equations)

<http://www.chymist.com/Names%20and%20symbols.pdf>
<http://richardbowles.tripod.com/chemistry/balance.htm>
<http://www.fordhamprep.org/gcurran/sho/sho/lessons/lesson53.htm>
<http://www.docbrown.info/page01/EICpdMix/ElcCmdMix3.htm>

8. Acids Bases and Salts

<http://chemistry.about.com/od/acidsbases/a/acidsbaseterms.html>
http://encyclopedia.kids.net.au/page/ac/Acid-base_reaction_theory
<http://www.chemtutor.com/acid.htm>
http://www.chem4kids.com/files/react_acidbase.html

9. Carbon and its Compounds

<http://en.wikipedia.org/wiki/Carbon>
http://www.chem4kids.com/files/elements/006_where.html

10. Synthetic Materials and Chemical Industries

<http://hsc.csu.edu.au/chemistry/options/industrial/2765/Ch956>
<http://hsc.csu.edu.au/chemistry/options/industrial/2764/Ch955>

11. Force and Pressure

http://kids.earth.nasa.gov/archive/air_pressure/
<http://www.darvill.clara.net/enforcemot/pressure.htm>
<http://apollo.lsc.vsc.edu/classes/me1130/notes/chapter8/index>

12. The Current Electricity

<http://www.chymist.com/Names%20and%20symbols.pdf>
<http://www.chymist.com/Names%20and%20symbols.pdf>
<http://www.chymist.com/Names%20and%20symbols.pdf>

13. Light and its Behaviour

http://www.opticalres.com/kidoptx_f.html
<http://www.kathimitchell.com/light.htm>
<http://www.creativekidsathome.com/science/light.html>
<http://science.howstuffworks.com/light.htm>
<http://www.explainthatstuff.com/light.html>
<http://42explore.com/light.htm>

14. Magnet and Magnetism

<http://www.historyforkids.org/scienceforkids/physics/electricity/magnet.htm>
<http://www.bnl.gov/slc/interactivewebsites.asp#Magnets>
<http://www.bnl.gov/slc/interactivewebsites.asp#Magnets>
<http://science.pppst.com/magnets.html>

15. The Earth and Space

<http://geology.com/articles/what-is-earth-science.shtml>
<http://www.kidsastronomy.com/earth.htm>
<http://www.enchantedlearning.com/subjects/astronomy/>
<http://www.kidsastronomy.com/>
<http://www.frontiernet.net/~kidpower/astronomy.html>

Sustenance of the Individual (Nutrition and Respiration)

Learning Objectives

At the end of this unit, students should be able to:

- understand functions of food,
- understand and define nutrition and its types,
- understand and define photosynthesis,
- demonstrate by simple experiments that light, chlorophyll and carbon dioxide are necessary for photosynthesis,
- perform an experiment to demonstrate production of oxygen during photosynthesis,
- summarize the conditions necessary for photosynthesis in the form of chemical equation,
- generalize that photosynthesis provides food and oxygen for all living organisms,
- describe heterotrophic modes of nutrition in plants,
- list various processes involved in nutrition in higher animals,
- give examples of different modes of nutrition in higher animals,
- understand and define digestion and name different parts of the alimentary canal,
- explain functions of each part of the alimentary canal and understand that digestion is followed by absorption and assimilation,
- draw and label parts of the digestive system of human beings,
- understand and define respiration and differentiate between internal respiration and external respiration,
- understand that respiration is an energy-releasing continuous process occurring day and night,
- explain respiration in plants,
- draw and label parts of the respiratory system of human beings,
- understand breathing mechanism in human.

INTRODUCTION

All living organisms perform some basic functions to stay alive. These are known as **life functions** or **life processes**. Some of these basic life processes are nutrition, respiration, growth, response to stimuli, excretion and reproduction.

FOOD, NUTRITION AND ENERGY

Food is a substance from which an organism derives its energy as well as materials for growth and maintenance. The process of eating the right kind of food is called **nutrition**.

All life processes require energy. Energy is 'locked' in the form of chemical energy in food. To 'unlock' or release this energy, the food must first be converted into smaller and soluble molecules. This happens during the process of **digestion**. Next, energy must be set free from these molecules. This happens when the molecules react chemically with oxygen in the body cells during **respiration**.

Thus, **nutrition and respiration are the two life processes that provide energy to living organisms to stay alive**. We will study these two energy-providing processes in detail.

TYPES OF NUTRITION

Green plants prepare their own food by using non-living components of the environment. This mode of nutrition is known as **autotrophic nutrition**. Green plants are known as **autotrophs**.

The living world consists of organisms that show two main kinds of nutrition (i) autotrophic and (ii) heterotrophic. *Name the food making process of green plants. It also writes the equation for it.*

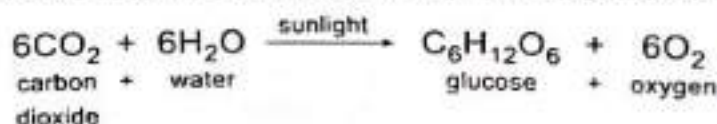
(i) AUTOTROPHIC NUTRITION

Green leaves and young stems of plants contain numerous green structures called **chloroplasts** in their cells.

The chloroplasts are green because of the presence of a green pigment called **chlorophyll**. It is chlorophyll that traps energy from sunlight. Plants also need water and minerals to prepare food. Roots of the plants contain root hairs at its tips. Root hairs absorb water and minerals from the soil. Water is available in the soil abundantly. Even in dry soil, it is found in the sand particles in the form of **hygroscopic layer**. Minerals are found in the form of thin solutions in the soil.

The water and minerals which are absorbed by the plants are transported to other parts of the plant through a type of conducting tissues called **xylem**.

Using the energy from the sun, a chemical reaction takes place in the green parts of the plant, in which carbon dioxide and water are converted into plant food in the form of glucose.



In most plants, glucose is converted into starch and stored in leaves, stems, roots, etc. Oxygen is released in the process. **The process of manufacturing food in green plants is known as photosynthesis.** The food which is synthesized by the green

Good to know

Poinsettia is a light-sensitive plant. If it is kept in the dark for some time, chlorophyll will not be produced and only red pigment develops which turns leaves red.

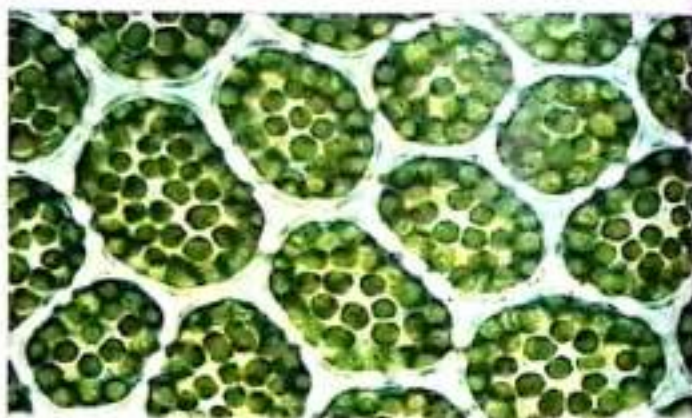


Fig. 1.1 Chloroplasts in leaf cells

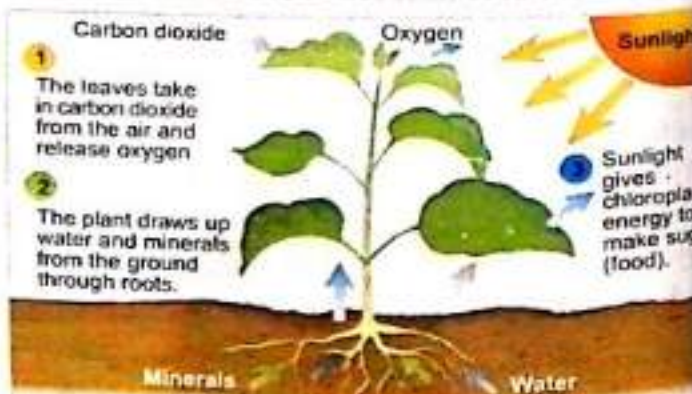


Fig. 1.2 The process of photosynthesis

leaves is transported to the other parts of the plant by a type of conducting tissues called phloem.

The food that plants make is used not only by themselves but also by the entire living world. Besides, photosynthesis helps to maintain the balance between oxygen and carbon dioxide in the atmosphere.

The simplest method of testing whether photosynthesis has taken place or not is to find out if starch is present in a leaf with the help of iodine as starch indicator.

ACTIVITY TIME! To test a leaf for starch.

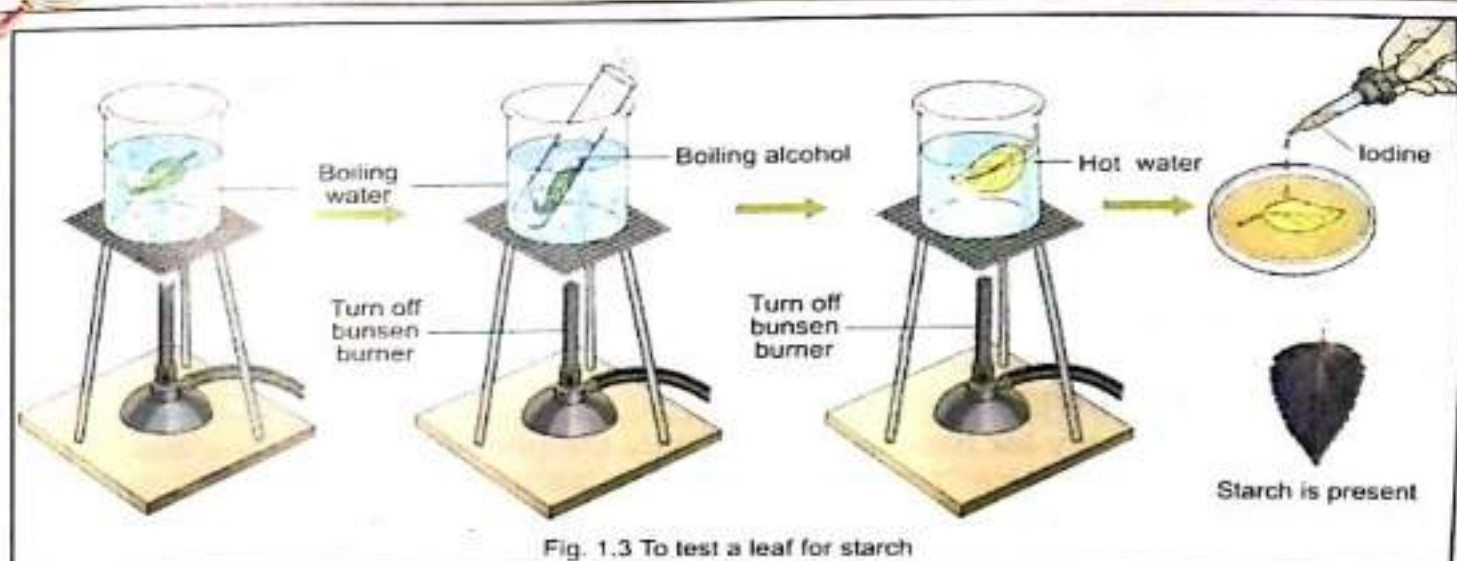


Fig. 1.3 To test a leaf for starch

- ❑ Pluck a leaf from a plant which has been exposed to sunlight. Boil it for five minutes in water. Place it in a test tube containing alcohol. Place the test tube in a beaker containing water and warm the water gently until the alcohol begins to boil. (Do not allow the water to boil) The alcohol will dissolve the chlorophyll and the leaf will lose its green colour (Fig. 1.3).
- ❑ Wash the leaf in warm water to remove the alcohol. Now soak the leaf in a dish containing dilute iodine solution for five minutes. Remove the leaf from the iodine and wash it with water. Hold it up against light. If starch is present, a blue-black colour will be seen on the leaf surface.

Photosynthesis is affected by light

Another simple experiment can be carried out to show that photosynthesis is affected by light.

ACTIVITY TIME! To verify that light is necessary for photosynthesis.

- ❑ Select a potted plant with long leaves, for example, Hibiscus, and keep it in a dark room for more than 24 hours. Photosynthesis will not occur and the leaves will become starch-free.

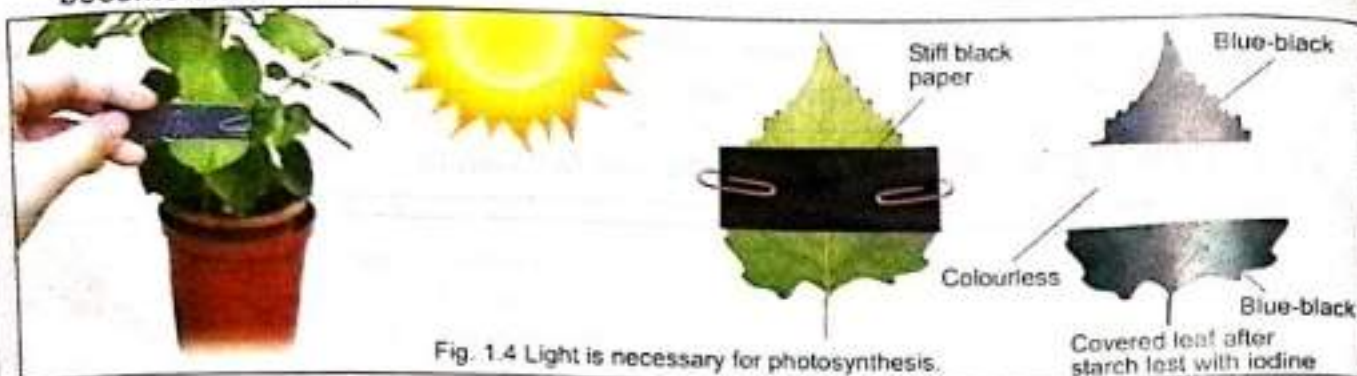


Fig. 1.4 Light is necessary for photosynthesis.

- ❑ Take two similar strips of stiff black paper or cardboard and cover both sides of a portion of a leaf with them. Use paper clips to secure the strips in place.
- ❑ Now keep the plant in sunlight. The covered portion of the leaf will not receive sunlight whereas the uncovered portion will receive proper sunlight.
- ❑ After a few hours, pluck the leaf.
- ❑ Remove the strips and test it for starch.

Since light is necessary for photosynthesis, only the uncovered portion of the leaf will show the presence of starch. The covered portion will not turn blue-black showing that there is no starch present in the portion that did not receive light as shown in Fig. 1.4.

ACTIVITY TIME! To verify that photosynthesis produces oxygen gas.

Fill a beaker three-fourth with water. Put some twigs of an aquatic plant (Hydrilla) in it. Cover the plant with a glass funnel. Carefully invert a test tube full of water over the stem of the funnel. Keep the arrangement in sunlight. You will find bubbles of a gas escaping from the leaves of the plant into the test tube. Bring a burning matchstick into the test tube, it will burn brightly proving that the gas in the test tube is oxygen.

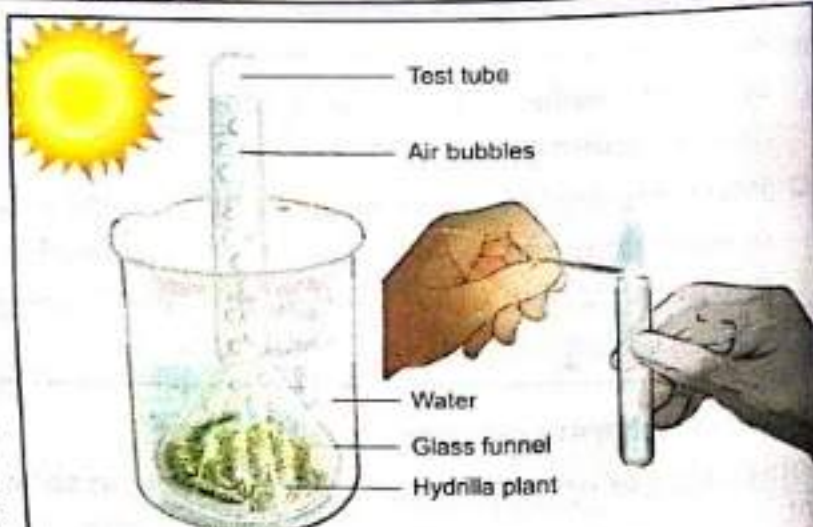
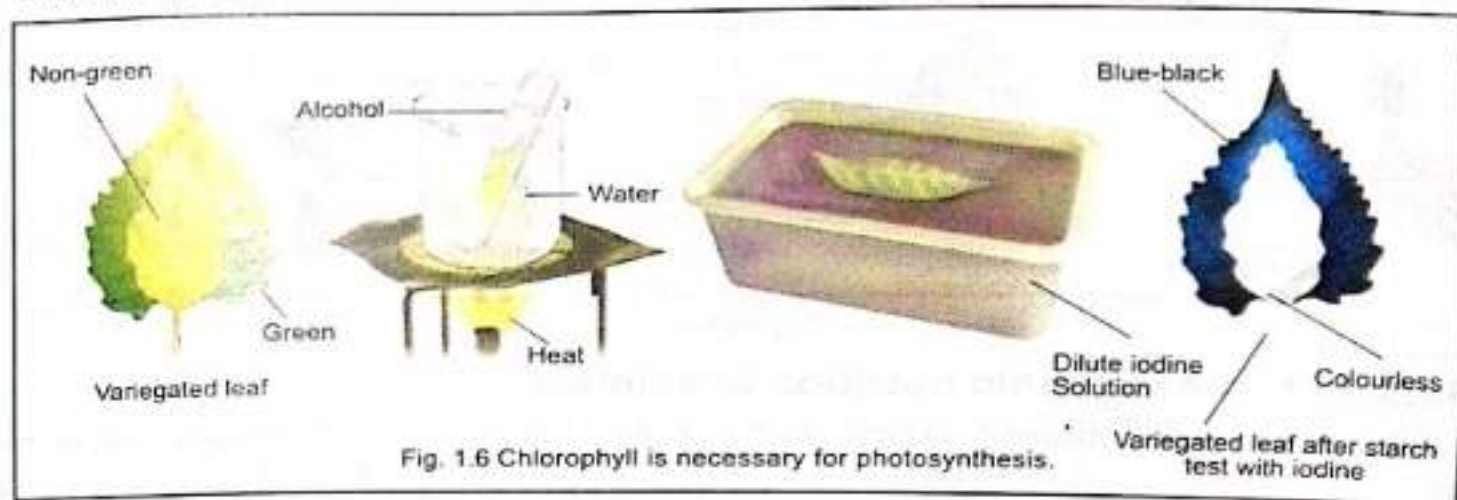


Fig. 1.5 Photosynthesis produces oxygen

ACTIVITY TIME! To verify that chlorophyll is necessary for photosynthesis.

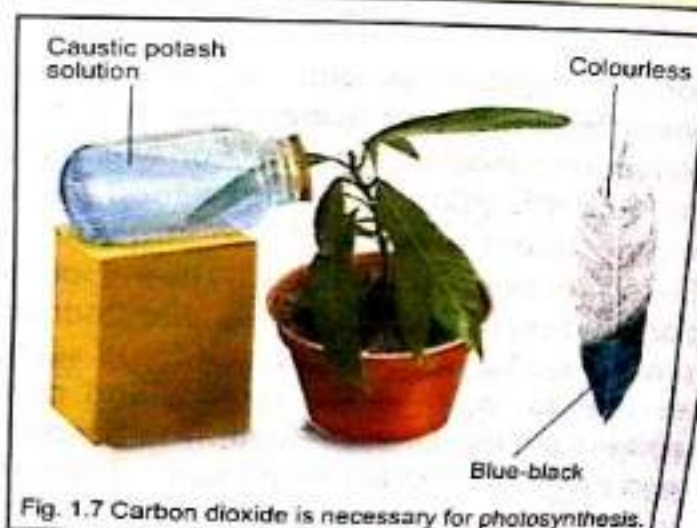
The leaves of plants, such as coleus and croton, are partly green and partly non-green. These leaves are called **variegated** leaves. Chlorophyll is present only in their green portions. Select such a leaf from a plant that has been exposed to sunlight for a few hours and draw its outline on a piece of paper. Indicate the green and non-green areas on the drawing. Test the leaf for starch. Compare the parts stained blue-black with the drawing. Which parts of the leaf turn blue-black? Why doesn't the non-green portion show the presence of starch?



ACTIVITY TIME! To verify that carbon dioxide is necessary for photosynthesis.

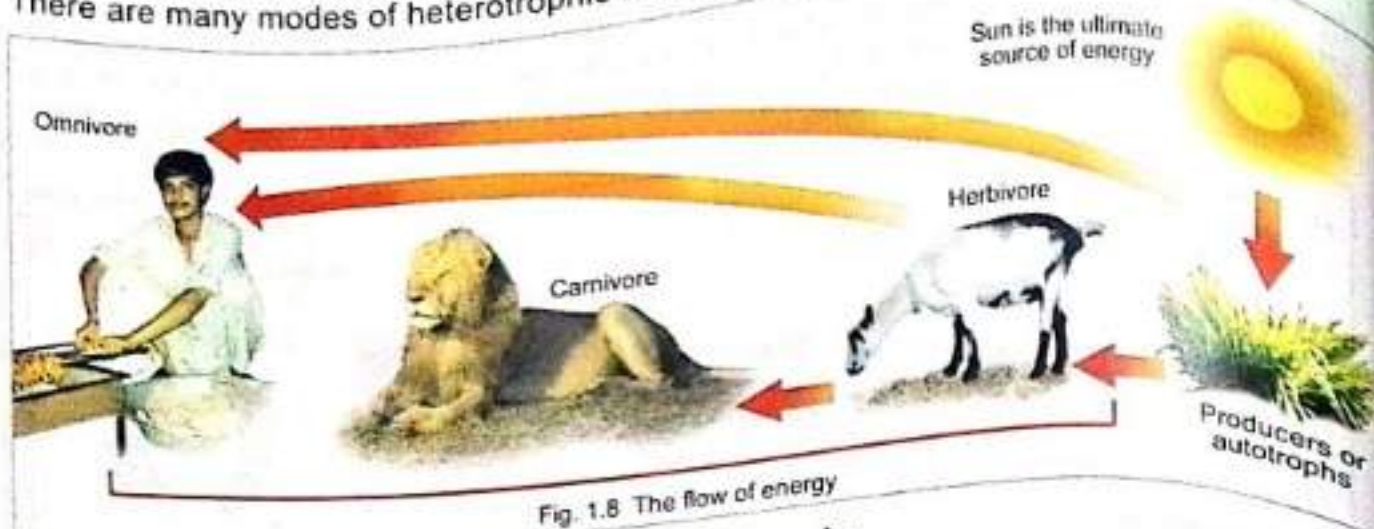
Select a potted plant with long leaves. Keep it in the dark for more than 24 hours to destarch it. Put a little concentrated solution of caustic potash in a bottle fitted with a tight stopper. Select a leaf from the plant. Insert half of it in the bottle and let the other half remain outside, as shown in Figure 1.7. Caustic potash absorbs carbon dioxide. The portion of the leaf in the bottle, therefore, will not get carbon dioxide, while the portion outside the bottle will get carbon dioxide from air.

Cork the bottle and place it in sunlight for a few hours. Test the leaf for starch. Which portion of the leaf turns blue-black? What do you conclude from the result?



(ii) HETEROTROPHIC NUTRITION

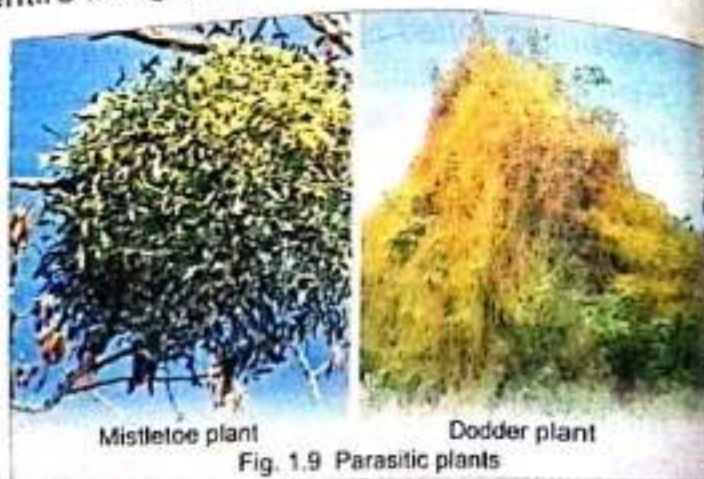
Animals and non-green plants, such as fungi and bacteria cannot prepare their own food. They depend directly or indirectly on green plants for their nutrition. This method of nutrition is called **heterotrophic nutrition**. Animals and non-green plants are known as heterotrophs. There are many modes of heterotrophic nutrition in animals.

**Modes of heterotrophic nutrition in animals**

Herbivorous animals depend directly on plants for their nutrition. Carnivores depend on other animals and eat their meat while omnivorous animals feed on both plants as well as animals. (Fig. 1.8). Thus, when you eat meat, you are indirectly eating food prepared by plants. You know that green plants get the energy to prepare food from the sun. Thus, the sun is the ultimate source of energy in the entire living world.

② Heterotrophic nutrition in plants

Some non-green as well as green plants live or feed on other living organisms and derive their food from them. For example, dodder is a plant that sucks food from another plant using root-like structures. Such plants are called **parasites**. Some parasitic plants like mistletoe and dodder plant (Fig. 1.9), which grow on trees such as mango, have green leaves and can perform photosynthesis. But they take water and minerals from the host plants. They are known as **partial parasites**.

**Good to know**

Some organisms live on dead plants and animals and derive their food from them. Examples are mushroom and other fungi and bacteria. They are known as **saprophytes**.



Fig. 1.10 Mushroom



Fig. 1.11 Venus fly trap and pitcher plant



The plant kingdom also has plants that consume insects. The venus fly trap and pitcher plant catch insects by ingenious methods (Fig. 1.11). Their cells secrete digestive juices to digest the insects. These plants grow in soil that is not so rich in inorganic nutrients and they obtain them from insects to supplement the food they prepare by photosynthesis. They are known as **insectivorous plants**.

Good to know

In another mode of nutrition, two different kinds of organisms work together for their mutual benefit. For example, algae, which is an autotroph, and fungus, which is a saprophyte, live together in a mutually beneficial association called **lichen**.

The fungus supplies water and minerals to the cells of the algae, while the algae supplies food to the fungus. Such a mutually beneficial.



Fig. 1.12 Lichen

Let's work in team!

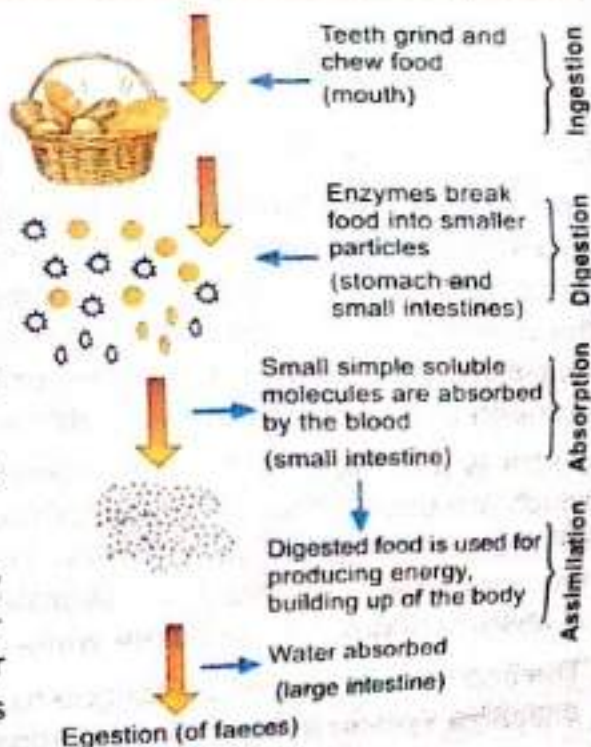


Divide in groups, each group must select an insectivorous plant or flower of their choice and compile a facts file based on its features and distinctive properties.

THE PROCESS OF HETEROTROPHIC NUTRITION IN ANIMALS

Following are the steps that are involved in the process of nutrition in animals that feed on solid food:

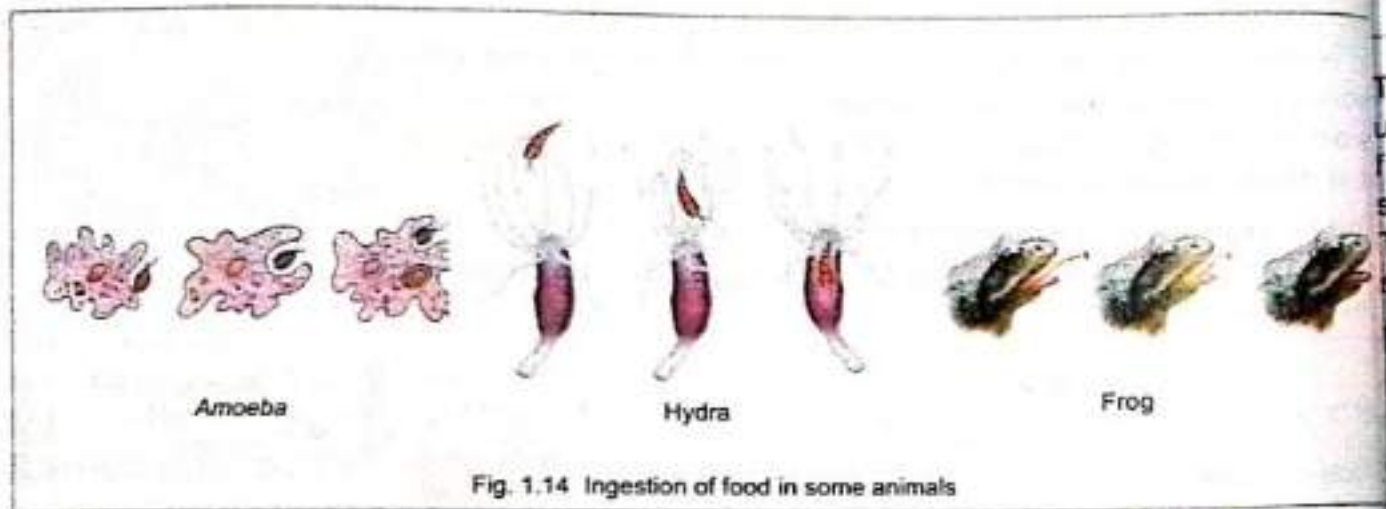
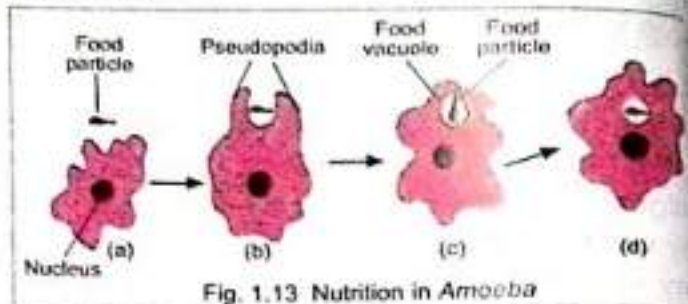
- ❑ **Ingestion** is the taking in of food inside the body. It involves obtaining and eating food.
- ❑ **Digestion** is the breakdown of food into a simple, water soluble form with the help of enzymes.
- ❑ **Absorption** is the process by which the water soluble food passes into the body fluids such as the blood.



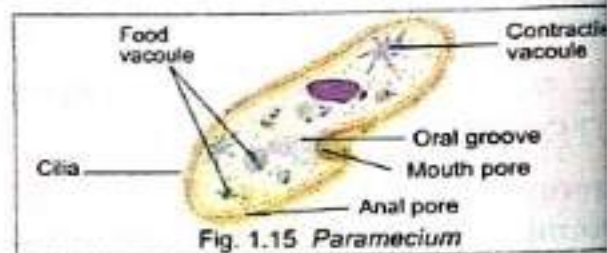
- **Assimilation** is the process of conversion of digested food into useable form and use of the absorbed food for producing energy and for growth.
- **Egestion** is the process by which the undigested solid parts of the food are eliminated from the body.

Heterotrophic nutrition in different animals

The unicellular *Amoeba* engulfs tiny particles of food by throwing its false feet, known as **pseudopodia** around it. The pseudopodia join together to form a small cavity known as a **food vacuole**. The food inside the vacuole is digested by enzymes (Fig. 1.13). It is absorbed and assimilated to provide energy and form new protoplasm.



The unicellular *Paramecium* has stiff hair-like structures called **cilia** all over its body which are used for ingestion. The constant movement of the cilia pushes the food particles into its mouth-like structure. The rest of the processes of nutrition are similar to those in *Amoeba*.



Hydra is a simple, multicellular animal. It has a number of **tentacles** around its mouth which are used for the ingestion of food. The tentacles entangle small aquatic animals and kill them with their **stinging cells**. They then push them into the mouth (Fig. 1.14). Inside the body cavity, the enzymes secreted by the surrounding cells help to digest the food. Food is absorbed through the cavity walls and assimilated in the cells.

The frog uses its long sticky tongue to catch insects (Fig. 1.14). Frogs have a well-developed digestive system in which food is digested with the help of enzymes.

Spiders weave a sticky web in which small insects get stuck. The spider then sucks up their juices. The mosquito sucks up the blood of animals with its proboscis (Fig. 1.16).



Fig. 1.16 Mouth parts of insects are modified to suit their feeding habits.

The housefly also lives on liquid food. It uses its saliva to dissolve the food and form a solution. Then it sucks up the solution with the help of its feeding tube. The butterfly also uses its proboscis to suck the nectar from flowers.

Heterotrophic nutrition in humans

Human food is of many types because humans are omnivores. Human digestive system is designed for carrying out the digestion of many kinds of food.

The human digestive system (Fig. 1.17) includes all the organs concerned with ingestion, digestion, absorption and egestion. The food that we eat passes through a long tube, about 9 m in length, called the **alimentary canal**.

This canal begins at the mouth through which the food is ingested. It ends at the anus, through which the undigested food is egested.

ROLE OF ENZYMES IN DIGESTION:

Enzymes are digestive juices secreted in various parts of the digestive system. They

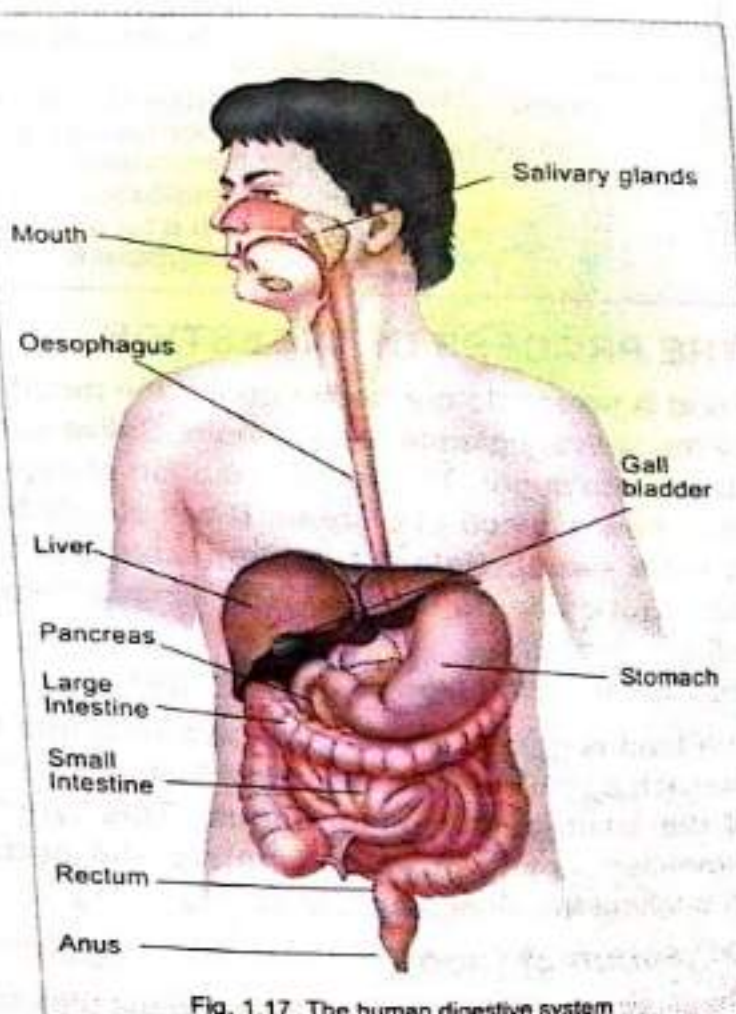


Fig. 1.17 The human digestive system

break large molecules into simpler water soluble molecules. Some of these are amylase, pepsin, trypsin, lipase and sucrase. The sources of enzymes and their roles in the digestive process are summarized in Table 1.1.

Table 1.1 Enzymes in the human digestive system

Part of digestive system	Enzyme	Secreted by	Action
mouth	amylase	salivary glands	changes starch to simpler sugar
stomach	pepsin	gastric glands	changes proteins to simpler molecules called peptides
duodenum	pancreatic juice containing several enzymes - trypsin, lipase and amylase	pancreas	changes proteins, peptides, sugars, starch and fats to simpler substances
ileum	intestinal juice containing several enzymes, such as maltase, sucrase, lactase and peptidase	intestinal glands	change partially digested proteins and carbohydrates to simpler substances

THE PROCESS OF INGESTION

Food is taken into our body through the mouth. It is then mixed with saliva, a liquid secreted by the salivary glands in the mouth. Saliva contains the enzyme amylase that breaks down starch into sugar. This is the initiation of digestion. You can actually taste this change as you chew a piece of chapati. It will slowly begin to taste sweet. Saliva also lubricates the food, making it easier to swallow. The tongue helps to roll and push the food into the food pipe or **oesophagus**.

The food is gently squeezed downwards into the stomach by the contractions of involuntary muscles of the walls of the oesophagus. This type of movement is known as **peristalsis** and occurs throughout the alimentary canal (Fig. 1.18).

Digestion of food

Food remains in the **stomach** for a few minutes to a few hours. During this period, thousands

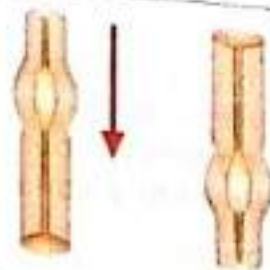


Fig. 1.18 Peristalsis occurs throughout the alimentary canal.

of glands in the stomach wall secrete digestive juices into the stomach. These juices contain an acid (HCl) and enzymes that break down proteins. The stomach muscles squeeze and churn the food, so that it gets properly mixed with the digestive juices.

From the stomach, the food is pushed into the **small intestine**. It is about 6 m long and is the longest part of the digestive system. Most of the digestion takes place in small intestines.

Some of these enzymes are produced in the wall of the small intestine while other enzymes are produced in a gland called the **pancreas** which is located behind the stomach. From pancreas, these enzymes reach the stomach.

Another digestive juice that acts on the food in the small intestine is the **bile**. It is produced in the liver. Bile is stored in another organ called the **gall bladder**. From there, it is released into the small intestine. **Bile performs an important function of breaking down fats into tiny droplets.** This makes it easier for enzymes to break down the fats into simpler substances. Digestion is completed in the small intestine.

Absorption of digested food

The next step is the absorption of the digested food into the blood, so that it can be carried to all the cells of the body. This also takes place in the small intestine. The inner wall of the small intestine has millions of tiny, finger-like projections called **villi** (singular: villus). Each villus has fine blood capillaries in it (Fig. 1.19). The digested food passes through the intestinal walls into the blood of these capillaries.

After absorption in the small intestine, the remaining undigested food mixes with water and moves into the **large intestine**. The large intestine absorbs most of the water.

Egestion of undigested food

The semi-solid mass of undigested food left after absorption of water in the large intestine is called **faeces**. It is stored in the **rectum**, and is passed out of the body through the **anus**.

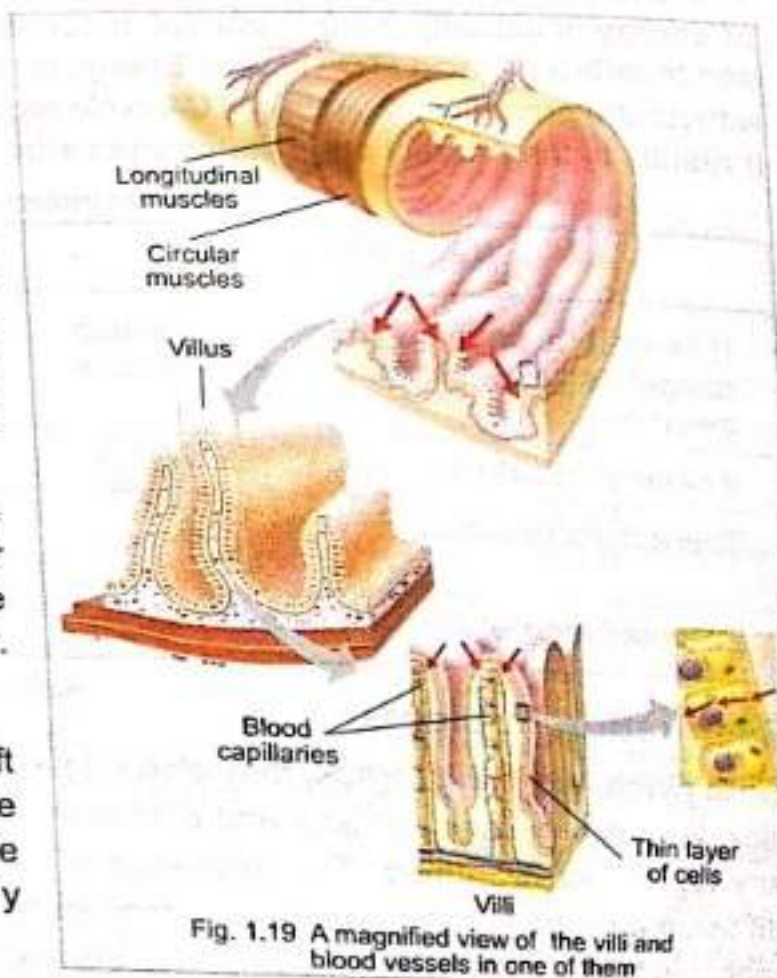


Fig. 1.19 A magnified view of the villi and blood vessels in one of them

RESPIRATION IN LIVING ORGANISMS

During the process of respiration, the digested food reacts chemically with oxygen in the

body cells to release energy. The reaction with oxygen is known as **oxidation**. Respiration is the process of taking in oxygen, which is used to release

energy by the oxidation of food, and eliminating the waste products—carbon dioxide and water.

The two main processes of respiration are:

- ❑ **breathing or external respiration:** it is the physical process of taking in oxygen and giving out carbon dioxide.
- ❑ **internal respiration or cellular respiration:** it is the chemical process of using oxygen to break down food to release energy. Internal respiration occurs in organelles called **mitochondria** which are found in every living cell.

The process of breaking down of glucose into carbon dioxide and water with the release of energy is actually a very complex process. It happens in two main stages—glycolysis and tricarboxylic acid (TCA) cycle. Energy is released in both processes. Glycolysis occurs without the presence of oxygen. TCA cycle requires oxygen and involves complex reactions. It results in the production of water and carbon dioxide.

Table 1.2 Differences between breathing and respiration

Breathing	Respiration
It is only a physical process in which oxygen is taken in and carbon dioxide is given out.	It is a biochemical process in which glucose is oxidised to produce carbon dioxide and water.
It occurs outside the cells.	It occurs inside the cells.
There is no release of energy.	There is a gradual and stepwise release of energy.
Enzymes are not involved in the process.	Enzymes are involved in the process.

Respiration in plants

Since plants are living beings, they also respire by taking in oxygen and giving out carbon dioxide. It is a cellular process and occurs in mitochondria. Generally plants do not have any organs for breathing. The exchange of oxygen and carbon dioxide takes place by diffusion through small pores called stomata (singular: stoma) present in the leaves and lenticels which are found in the stem. Stomata along with its nearby guard cells and subsidiary cells are called **stomatal apparatus** (Fig. 1.20).

Guard cells are two paired cells. They make up the stomata with an opening that lies

between them. The expansion and shrinking of guard cells occurs due to the supply of moisture and light and results in opening and closing of stomata. Gaseous exchange occurs frequently in the leaves and occasionally on the other parts of the shoot. Generally, it occurs during the day time. But the rate of exchange of gases in animals is much faster than in plants. In cellular respiration, glucose molecules break down into carbon dioxide (CO_2) and water (H_2O) in the presence of oxygen (O_2) to release energy. The chemical reaction involved in respiration is summarised as below:

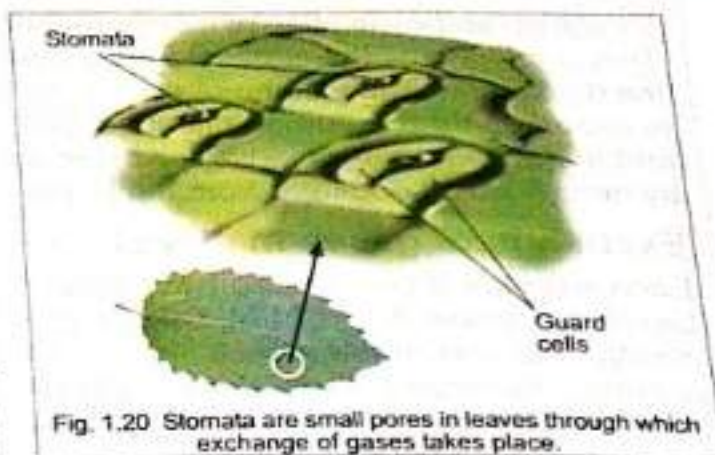
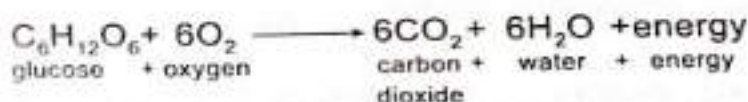


Fig. 1.20 Stomata are small pores in leaves through which exchange of gases takes place.

Respiration in humans

The main organs of respiration in humans are the lungs. The other organs are the nostrils, nasal cavity, trachea or wind pipe and bronchi (Fig. 1.21 a).

Humans respiratory track

Air enters the body through the **nostrils** or mouth. As it passes through the nostrils, it is moistened by the slimy mucous present in the nose and warmed by the blood circulating in the nose. The hair present inside the nose clean the air by trapping dust particles and bacteria. From the **nasal cavity**, the air passes through the pharynx into the **trachea**. The trachea branches into two smaller tubes called the **bronchi**. Each bronchus enters a **lung**.

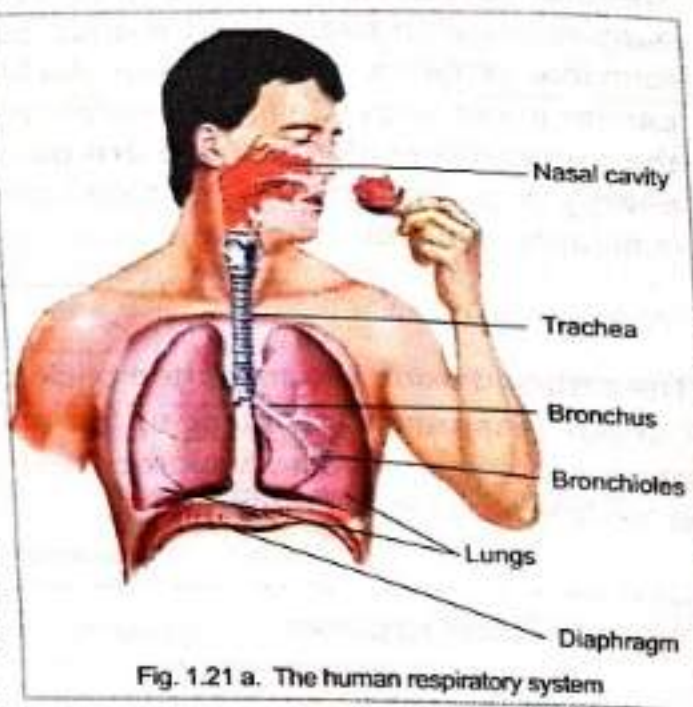


Fig. 1.21 a. The human respiratory system

The uppermost part of the trachea is called the **larynx** or **voice box**. The larynx contains ligaments called **vocal cords**. They vibrate to produce sound, enabling you to speak. Within the lungs, each bronchus branches again and again into very small tubes called **bronchioles**. At the end of these tubes are tiny air sacs called **alveoli** (singular: alveolus). Each lung contains about 300 million alveoli! The air we breathe in, eventually reaches the alveoli. When you inhale or breathe in, you bring in a fresh supply of oxygen to the lungs. When you exhale or breathe out, you get rid of the carbon dioxide as waste.

Inhalation and exhalation of air occurs because of expansion and contraction of the lungs. This is caused by the expansion and contraction of the muscles attached to the ribs and the diaphragm. The volume of air that moves in or goes out of the lungs in a single breath is known as **tidal volume**. It is about 500 ml in humans. It decreases during rest or sleep and increases during running or exercising. The breathing rate in our body is regulated by nerves which originate from the brain.

Exchange of gases in alveoli

Each alveolus is surrounded by a network of thin blood vessels (Fig. 1.21 b). Oxygen passes through the wall of the alveoli into the blood vessels. The blood then carries the oxygen to the body cells. Meanwhile, the carbon dioxide present in the blood as a waste product of respiration passes out of the blood vessels and into the alveoli.



Fig. 1.21 b. The exchange of gases takes place between the alveoli and blood capillaries.

Cellular respiration: The blood takes the oxygen to all cells of the body. Blood has a substance called **haemoglobin** which binds oxygen to form **oxyhaemoglobin**. It is in this form that oxygen is carried through the blood. This substance is, therefore, the **respiratory carrier** in our body. Cellular respiration occurs in the cells. **During cellular respiration the sugar molecules in food are oxidized to form carbon dioxide and water, and energy is given out.** The reaction involved in oxidation is the same as that of cellular respiration in plants as follows:



The carbon dioxide is transported back to the lungs through the blood.

Cellular respiration is similar to the chemical reaction that occurs during burning or combustion. However, the two processes differ from each other. The differences are shown in the following table. (Table 1.3).

Table 1.3. Difference between combustion and cellular respiration

Combustion	Cellular respiration
It is a fast process.	It is a slow process.
It occurs at high temperature.	It occurs at body temperature.
It can occur anywhere.	It occurs only in living cells.
In this process, energy is released in a single step in the form of heat and light.	In this process, energy is released step by step and stored in molecules called ATP.

ACTIVITY TIME! To show that exhaled air has more carbon dioxide than inhaled air.

Take two test tubes each half-filled with lime water. Using two-holed stoppers, glass tubes and clips, set up the apparatus shown in Fig. 1.22. Use the rubber tube to breathe in and out through the mouth. As you suck in air, open clip X and close clip Y. The inhaled air moves up through lime water in test tube A. As you exhale, open clip Y and close clip X. The exhaled air passes through the lime water in test tube B. In which test tube does the lime water turn milky first? What does this show?

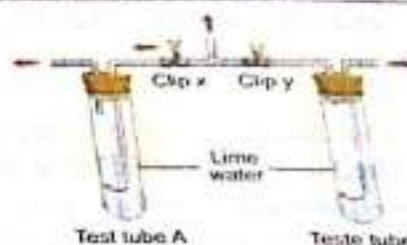


Fig. 1.22 To show that exhaled air has more carbon dioxide than inhaled air

Amazing facts!

In plants, both photosynthesis and respiration occur during the day. So, plants take in both CO_2 and O_2 for the two processes respectively. However, photosynthesis does not occur at night and only respiration takes place, which means that CO_2 is released by plants at night.

Let's work in team!

Make a working model of human respiratory system with the help of balloons, pipes and rubber bands. Take guidance from your teacher.

Teacher's corner

Explain the following facts to students:

- (1) Why do athletes use glucose tablets before race?
- (2) If you eat a plain biscuit, it will start tasting sweet in your mouth after sometime.

KEY POINTS

Here is a list of key points to remember:

- 🔍 The basic life processes performed by all living organisms are: nutrition, digestion, respiration, excretion, response to stimuli, growth and reproduction, etc. Nutrition, digestion and respiration provide energy.
- 🔍 Green plants are autotrophs. All non-green plants and animals are heterotrophs.
- 🔍 The process of nutrition in animals involves ingestion, digestion, absorption, assimilation and egestion.
- 🔍 Animals get their food in different ways. Some animals live only on liquid food.
- 🔍 From the mouth, the food passes through the oesophagus by muscular movements called peristalsis. It enters the stomach where the muscles squeeze and churn the food with the digestive juices.

- 🔑 From the stomach, the food goes to the small intestine where enzymes and digestive juices complete the digestion. Enzymes are secreted by the stomach, small intestine and the pancreas. The liver secretes the bile which breaks down fat into tiny droplets.
- 🔑 Absorption of digested food into the blood occurs through the villi present in the inner walls of the small intestine.
- 🔑 The undigested food then passes into the large intestine where excess water is absorbed. The faeces are collected in the rectum and passed out through the anus.
- 🔑 Respiration is the process of release of energy from digested food using oxygen. It consists of breathing and cellular respiration.
- 🔑 In humans, the main organs of respiration are nostrils, nasal cavity, trachea, bronchi and lungs.
- 🔑 Exchange of gases takes place in the alveoli which are surrounded by blood vessels.
- 🔑 The blood takes oxygen to the cells where cellular respiration occurs. The carbon dioxide passes into the blood and then into the alveoli.

KEY WORDS

Nutrition:	obtaining food necessary for healthy growth.
Photosynthesis:	process by which plants make food.
Stimulus:	a change that produces a response.
Parasites:	organisms that feed on another organism.
Tentacles:	flexible, long limbs of an animal.
Proboscis:	sucking organ of some insects.
Mucous:	a thick sticky liquid present in trachea.
Hygroscopic:	a substance that absorbs water from air.
Autotrophs:	organisms that can manufacture their own food.
Stiff:	strong.
Enzymes:	bio catalysts that speed up biochemical reactions.
Stinging:	causing wounds on body.
Alimentary:	related to food.
Lenticles:	porous tissues of stem.
Haemoglobin:	a kind of red protein.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. List the basic life processes performed by all living organisms.
2. Differentiate between autotrophs and heterotrophs, giving examples of each.
3. Write down the chemical equation of the food manufacturing process of green plants.
4. How will you test a leaf for starch? Mention any precautions that you will take.
5. All animals, whether herbivores, carnivores or omnivores, depend on plants for their food. Discuss briefly.
6. Name the organs that make up the alimentary canal.
7. Which digestive process takes place in the mouth?
8. What are enzymes? Give at least one example.
9. What is peristalsis? Draw diagrams to show peristalsis.
10. The stomach has thick muscular walls. What is the function of these muscles?
11. Explain the digestive processes taking place in the small intestine.
12. How does bile help in the digestion of fats?
13. Explain how food is absorbed into the blood in the small intestine.
14. Name and explain in one sentence each the two main processes of respiration.
15. How do the nostrils contribute to the process of breathing?
16. Explain, with the help of a diagram, the structure of human lungs and exchange of gases in the lungs.
17. Briefly describe the process of cellular respiration?
18. How are combustion and cellular respiration similar to each other? In what ways are they different?
19. How will you show that exhaled air has more carbon dioxide than inhaled air?
20. What is the difference between breathing and cellular respiration?

B. Fill in the following blanks:

1. Living organisms that cannot make their own food are called
2. A mutually beneficial relationship between two living organisms is called
3. Starch turns iodine
4. The cavity in unicellular animals in which food is present is called a food
5. Saliva contains the enzyme
6. During cellular respiration, the sugar molecules in food are to form carbon dioxide and water.
7. Trace the path of oxygen in humans during respiration by filling in the blanks with the main organs of the respiratory system in correct order: Nostrils and nasal cavity lungs blood.
8. The blood component that transports oxygen is
9. The two life processes that provide energy to living organisms are and
10. The stages in the process of nutrition in animals are ingestion....., and

C. Write TRUE/FALSE for the statements given below:

1. The sun is the ultimate source of all the energy needs of our body.
2. Saliva changes starch into sugar.
3. Most of the digestion of food takes place in the stomach.
4. The main function of the large intestine is to remove excess water from the undigested food.
5. All plants are autotrophic.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Give one-word answers of the following questions:

1. What are the cell organelles that contain chlorophyll called?

2. Can photosynthesis occur without oxygen?
3. What is the name given to the process of using absorbed food for producing energy?
4. Does digestion begin in the mouth or the stomach?
5. What is the name given to the contractions of the muscular walls of the oesophagus that squeeze food downwards into the stomach?
6. What are the tiny finger-like structures in the inner wall of the small intestine called?
7. What are the pores in the stems of plants through which exchange of gases takes place called?
8. If this organ in the trachea is damaged, you may not be able to speak. Name that organ.
9. The name of respiration that takes place without oxygen is.
10. Which of these two processes occurs at body temperature? Combustion or cellular respiration.

E. Choose the most appropriate answer for the following statements:

1. The life processes that provide energy are
a. nutrition. b. respiration. c. both nutrition and respiration d. response to stimuli.
2. Which of these are autotrophs?
a. all plants b. unicellular organisms c. all animals d. only green plants
3. Which of these is not necessary for photosynthesis?
a. oxygen b. chlorophyll c. light d. carbon dioxide
4. Which of these is not a part of nutrition?
a. digestion b. absorption c. egestion d. respiration
5. The greatest amount of digestion of food takes place in the
a. mouth. b. stomach. c. small intestine. d. large intestine.
6. Which organ produces bile?
a. pancreas b. stomach c. liver d. gall bladder
7. Within the lungs, the exchange of gases takes place in the:
a. bronchi. b. bronchioles. c. alveoli. d. trachea.
8. Which organ does Hydra use for the ingestion of food?
a. tentacles b. pseudopodia c. mouth d. cillia

9. The substance that is called the respiratory carrier in our body is:
a. oxygen b. haemoglobin c. oxyhaemoglobin d. carbon dioxide
10. In plants the gaseous exchange occurs through:
a. roots b. phloem c. xylem d. stomata

Homework Assignment



Keep a small plant in a room where there is no sunlight but lit with bulbs. Keep it well watered (for 5 days or so) then put it back in sunlit area. Make an observation chart and share the changes you noticed in the plant (under both conditions) with the classmates.

FUN WITH SCIENCE

To study the effect of saliva

You have seen that saliva contains a compound that converts starch into sugar. Let us study this change.

You will need • saliva • test tubes • starch • glass slides • iodine solution • lemon juice • sodium bicarbonate

Procedure:

- ❑ Take a little of your saliva in a test tube. In another test tube boil some starch (the starch that is used to starch our clothes). Put a drop of boiled starch on a glass slide. Add to it a drop of iodine solution. It will turn blue-black showing the presence of starch.

- ❑ Now add some boiled starch to the saliva. Test the resulting solution for starch. Is starch present now? Why?

You can use the experiment to see the effect of different conditions on the enzyme in saliva. Do the experiment after

- a. heating the saliva,
- b. adding a mild acid such as lemon juice to it, or
- c. adding a mild alkali such as sodium bicarbonate to it.

In which case are the enzymes in saliva that change starch to sugar destroyed?

Sustenance of the Individual (Transport)

Learning Objectives

At the end of this unit, students should be able to:

- understand and describe structure of root, stem and leaf,
- understand and describe the process of absorption of water and mineral salts by the roots in a plant,
- understand and describe the transport of water and manufactured food in a flowering plant,
- understand and describe the human transport system,
- understand and describe internal and external structure of human heart,
- name, draw and label parts of circulatory system,
- understand and explain functioning of the heart and draw simple diagram to show flow of blood through the heart,
- differentiate between structures and functions of arteries, veins and capillaries,
- understand and explain structure and functions of blood,
- draw and label parts of the excretory system in humans,
- understand and explain the process of excretion,
- understand and explain the role of skin in excretion.

TRANSPORT OF MATERIALS

To stay alive, all living organisms need to transport materials from one part of the body to another. For example:

- Food and oxygen are transported to all cells in the body for respiration and growth.
- Waste products are transported from the cells to the organs that excrete them.

There are various methods by which materials are transported in plants and animals.

Transport in animals

The transport of nutrients in unicellular organisms, such as *Amoeba*, *Paramecium*, bacteria, etc. is very simple. The nutrients reach every part of the cell by diffusion. In simple aquatic multicellular organisms, such as *Hydra* and jellyfish, oxygen and nutrients are transported by water that circulates through their bodies. In mammals, blood is the medium of transport.

Transport in plants

In plants, transport of water and food takes place with the help of specialized tissues called xylem and phloem. These tissues are also called conductive tissues. They are found throughout the plant body.

INTERNAL STRUCTURE OF ROOT

Each root tip is the growing zone. The cells of this region are actively dividing to form new cells. These cells are said to be meristematic.

The piliferous layer

It is the outermost layer of cells bearing root hairs. A cuticle is absent in the piliferous layer.

This helps in the absorption of water and mineral salts from the soil.

The cortex

This is wide region consisting of many layers of parenchymatous cells with intercellular air spaces. The root cortex is a food storage tissue.

Vascular tissue

In the dicotyledonous root, the xylem and phloem are not bundled together. Bundles of phloem tissue alternate with bundles of xylem tissue and are separated by parenchymatous tissue. The xylem tissue conducts water and other substances absorbed from the soil and the phloem tissue conducts food.

The pith

The pith occupies only a small area in the center of the root. It is made up of parenchymatous tissues and serves to store food.

THE INTERNAL STRUCTURE OF A DICOT STEM

There are four main regions in a dicotyledonous stem.

- epidermis □ cortex
- vascular bundle □ pith

In a dicot stem, the xylem and phloem are grouped together to form vascular bundles. The vascular bundles are arranged in a ring. In each vascular bundle the phloem lies outside the xylem with a tissue called cambium between them.

Good to know

Paranchymatous tissues are basic tissues of plants consisting of cells with cell wall. These cells remain alive at maturity.

INTERNAL STRUCTURE OF A LEAF

There are three groups of tissues in a leaf.

- The epidermis □ The mesophyll □ The vascular tissue

The epidermis

The epidermis is the outermost layer. It is composed of a single layer of cells which cover

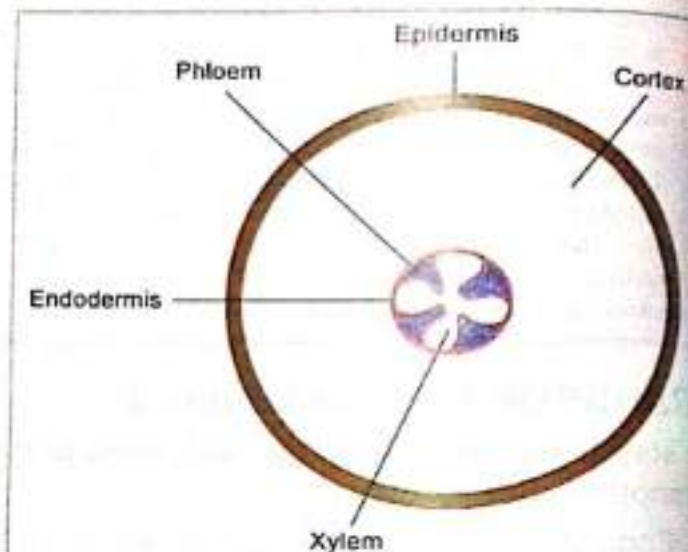


Fig. 2.1. Internal structure of a dicot root.

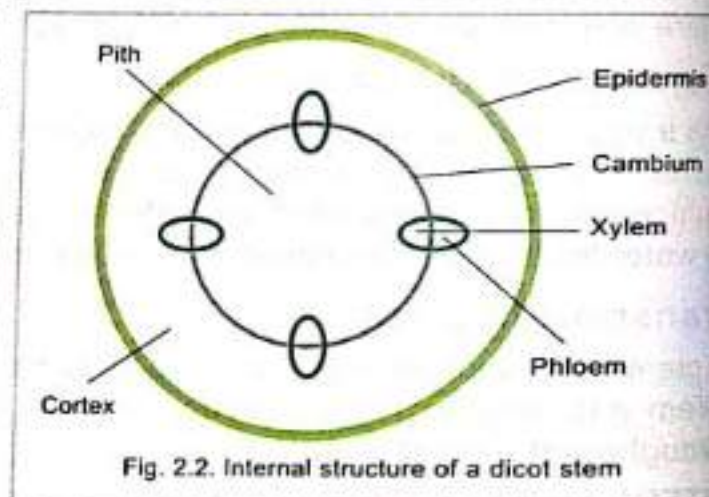


Fig. 2.2. Internal structure of a dicot stem

the entire leaf surface. A leaf has an upper and lower epidermis on its upper and lower surfaces respectively. The outer surface of the epidermal cells is covered by cuticle. Some of the epidermal cells are modified into stomata, which are more abundant on the lower surface of the leaves.

The mesophyll

It is the main region between the two epidermal layers. It is divided into two regions.

1. The palisade mesophyll
2. The spongy mesophyll

The palisade mesophyll consists of 2-3 layers of cylindrical cells. These cells contain many chloroplasts. Small intercellular spaces are present among them.

The spongy mesophyll consists of loosely arranged irregular cells with large intercellular spaces among them facilitating the diffusion of gases. The cells of this layer also contain chloroplasts.

The vascular tissue

The vascular bundles are present in the midrib and branch veins in the leaf. Each vascular bundle is made up of xylem, which occurs towards the upper epidermis, and phloem which occurs towards the lower epidermis.

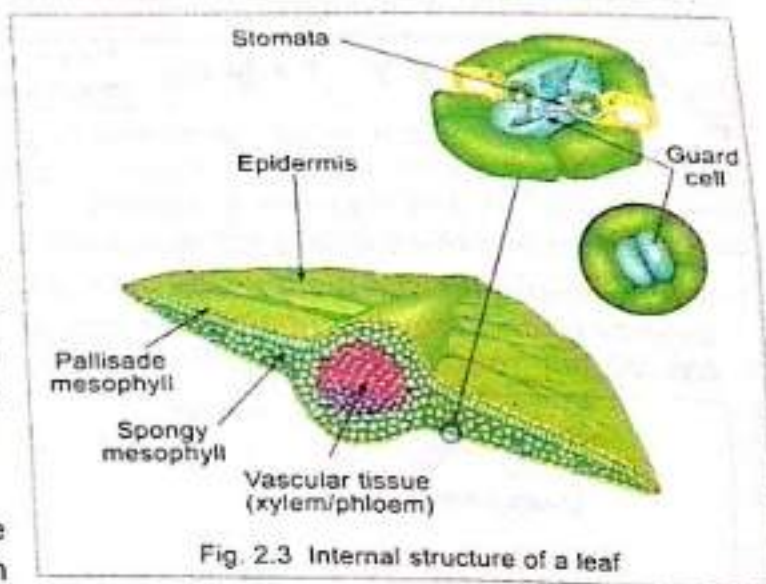


Fig. 2.3 Internal structure of a leaf

MEANS OF TRANSPORT

Following are the methods which bring about the transport of substance in the bodies of living organisms.

Diffusion

Diffusion is the movement of molecules of a solute from a solution where there is a higher concentration of its molecules to a solution where their concentration is low. The process of diffusion continues until the concentration of solute in all portions of the solution becomes equal. Diffusion is different from osmosis as it involves movement of molecules of gases, solutes and liquids other than water.

Osmosis

Osmosis can be regarded as a special case of diffusion. Osmosis is the movement of a solvent, usually water, from a region of higher concentration to a region of lower concentration through a semi-permeable membrane.

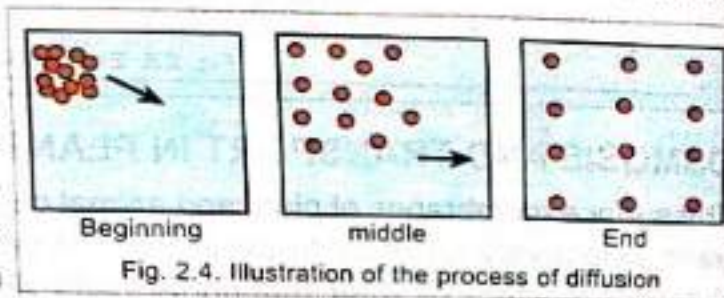


Fig. 2.4. Illustration of the process of diffusion

Good to know

Because of the constant random movement, the molecule of a gas tends to distribute themselves evenly throughout any space in which they are confined. The same principle holds true for substances which dissolve in a liquid, e.g. if a crystal of copper sulphate is placed at the bottom of a beaker of water, the blue colour of the solid will eventually spread through the water as the copper sulphate dissolves. This molecular movement in gases or liquids which tends to result in their uniform distribution is called diffusion.

ACTIVITY TIME! To show osmosis through a semi-permeable membrane.

A piece of semi-permeable membrane is stretched round a thistle funnel. The prepared funnel is filled with saturated sugar solution and turned upside down in a beaker of distilled water and clamped to an iron stand. The level of sugar solution in the funnel is marked and the setup is left to stand for a few hours.

A few hours later, the level inside the funnel will be seen to have risen. This has been caused by the movement of water through the membrane into the funnel. No sugar has passed out from the thistle funnel and this can be verified by tasting the distilled water.

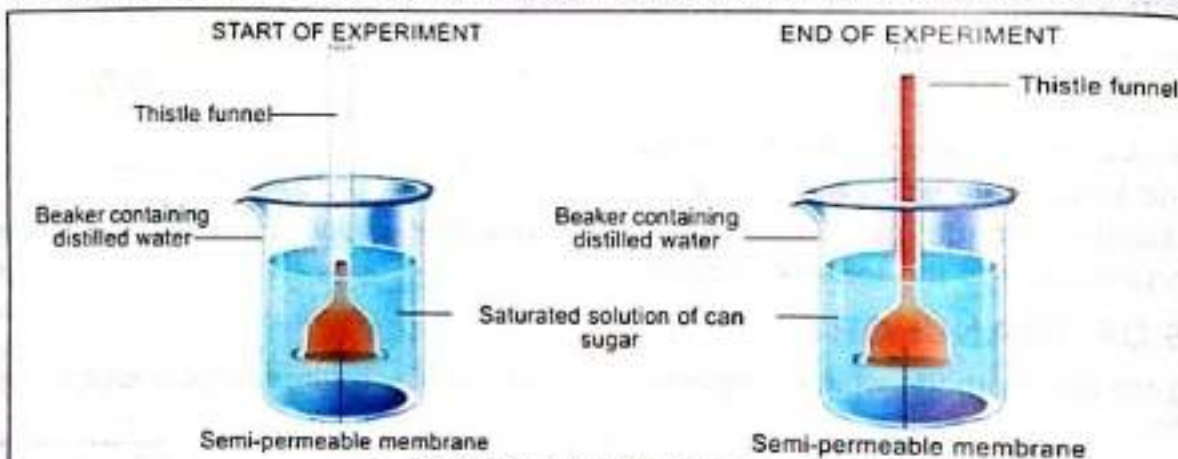


Fig. 2.5 Experiment to show osmosis

OSMOSIS AND TRANSPORT IN PLANTS

The surface membranes of plant and animal cells have selectively permeable properties. When these organisms or their individual cells are surrounded by fluids weaker or stronger than their own, osmotic forces are set up. Water moves from cell to cell in plants by osmosis. The cell membrane of a plant cell is semi-permeable. So, if a cell containing a weak solution is next to a cell with a stronger solution containing more

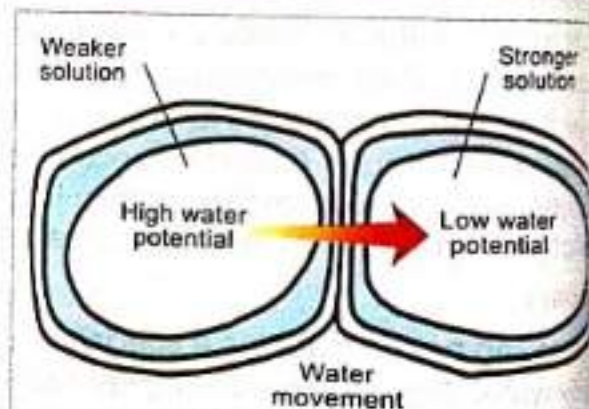


Fig. 2.6. Movement of water through cells

olute, water moves by osmosis from the weak to the strong solution, as shown in Fig.2.6. This process is used by root hair cells in the absorption of water from soil.

Good to know

A semi permeable membrane only allows smaller molecules to pass through it. Examples of semi permeable membrane include cell membrane, egg membrane, membrane of glomerulus in nephrons of kidneys etc.

ABSORPTION AND TRANSPORT OF WATER IN PLANTS

The root hairs are delicate hair-like projections of the cells of the outer layer of a root. Root hairs are the absorptive organs of the plant. The film of water which surrounds the soil particles also surrounds the root hairs. Soil water, with mineral salts dissolved in it, makes a very weak solution, and the cell sap of the root hair is stronger than it. Water, thus, moves from soil to root hair cells through osmosis, and this process occurs from cell to cell till it reaches the xylem vessels that carry it further upwards. With the help of this process, plant get their supply of water and mineral nutrients.

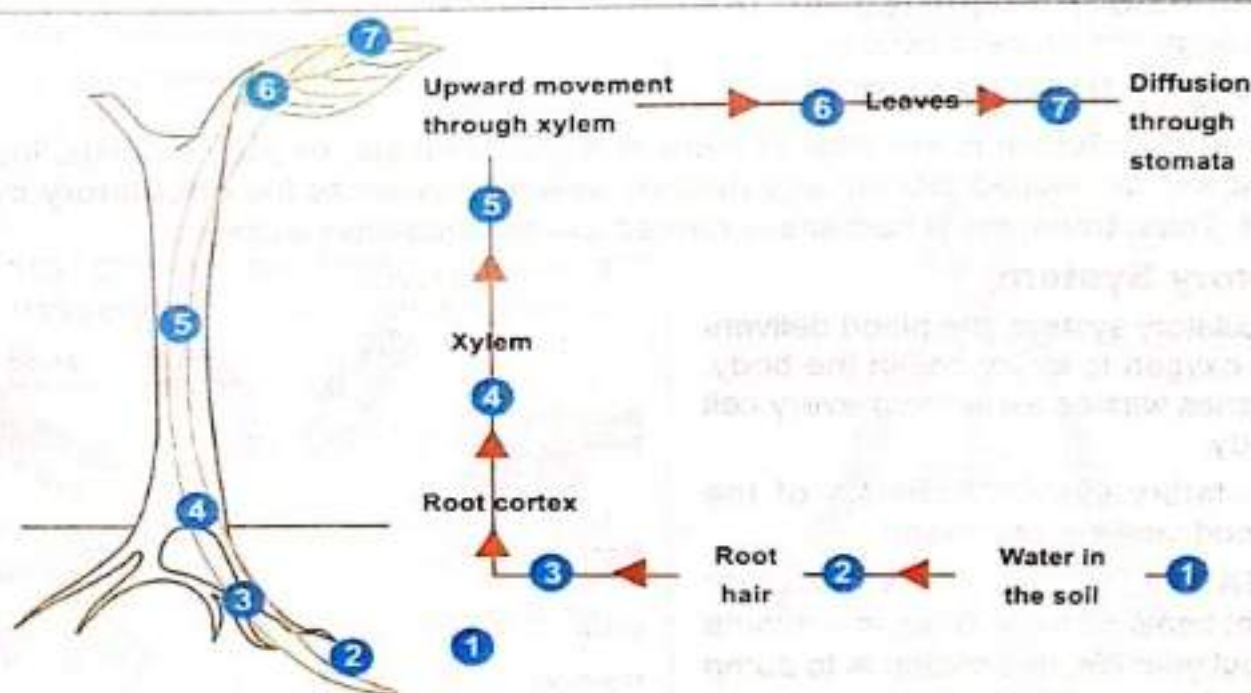


Fig. 2.7 Diagram to show the probable pathway of water from soil to xylem vessel in a root, stem and leaf.

TRANSPIRATION AND WATER MOVEMENT

Plants use only a small amount of the water they absorb from the soil. The rest of the water escapes in the form of water vapours through the stomata. The opening and closing of stomatal apertures regulates the loss of water vapour from the leaves. The process by which plants lose water as water vapours into the atmosphere is called **transpiration**. Most

of this loss takes place through the leaves but evaporation also occurs from stem, fruits and flowers.

The evaporation of water from the leaf surface also produces a pulling force which causes the water to move upwards. Transpiration also exerts cooling effect on plants.

TRANSPORT OF FOOD IN PLANTS

The food prepared by the leaves is transported to all parts of the plant in the form of a solution through a process known as **translocation**. Translocation takes place mainly from leaf cell to different parts of plant through phloem tissues. However, in some plants, substances made in the roots are also transported to the leaves through the phloem tissue.

TRANSPORT IN HUMANS

The process of diffusion is too slow to work in higher animals. In such animals, including humans, a well developed pick-up and delivery system, known as the **circulatory system** is present. Thus, transport in humans is carried out by circulatory system.

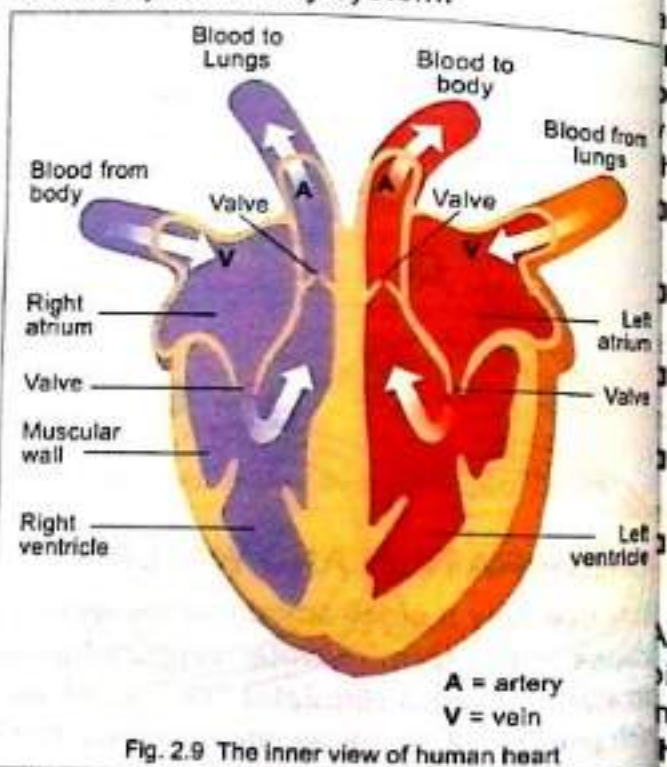
Circulatory System

In the circulatory system, the blood delivers food and oxygen to every cell in the body. It also carries wastes away from every cell in the body.

The circulatory system consists of the heart, blood vessels and blood.

THE HEART: The heart is a muscular organ that beats 60 to 80 times in a minute throughout your life. Its function is to pump blood to all parts of the body.

Internally, each side of the heart is divided into two parts or chambers. The top chambers with comparatively thinner walls are called **atria**. The two lower chambers with thick muscular walls are called **ventricles**. The right side of the heart, i.e. the **right atrium and ventricle**, receives



blood with carbon dioxide (deoxygenated blood) from all parts of the body to be sent to the lungs. Its left side, i.e. **the left auricle and ventricle, receives oxygen-rich blood** (oxygenated blood) from the lungs and sends it to all parts of the body (Fig. 2.9).

The left auricle receives oxygenated blood as it comes back to the heart from the lungs.

The right atrium receives deoxygenated blood from the rest of the body.

The right ventricle pumps the blood to the lungs.

The left ventricle pumps the blood to the rest of the body.

The heart has a number of **valves** that allow the blood to flow in one direction only.

FLOW OF BLOOD IN BLOOD VESSELS: With each heartbeat, blood is pumped into blood vessels called **arteries**. **Arteries carry blood away from the heart.**

ACTIVITY TIME: To feel your own pulse.

To feel the blood rushing through the arteries, place two fingers in the hollow spot on the wrist. The throbbing sensation or pulse that you can feel is actually blood rushing through the arteries.

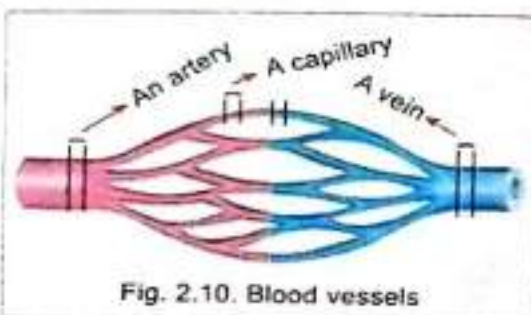


Fig. 2.10. Blood vessels

Arteries branch into smaller and smaller arteries, and finally into **capillaries** (Fig. 2.10). **Capillaries are the thinnest blood vessels**, about as thick as one of your hair. They have very thin walls. It is through these thin capillary walls that:

oxygen is picked up from the alveoli in the lungs.

digested food is picked up in the small intestine.

the oxygen and digested food are passed on to each cell of the body.

carbon dioxide and other wastes are picked up from every cell.

carbon dioxide is passed into the alveoli and wastes are passed into the kidneys.

After passing through the capillaries and picking up carbon dioxide, the blood flows into blood vessels called **veins**. **Veins carry the blood back to the heart.** Figure 2.11

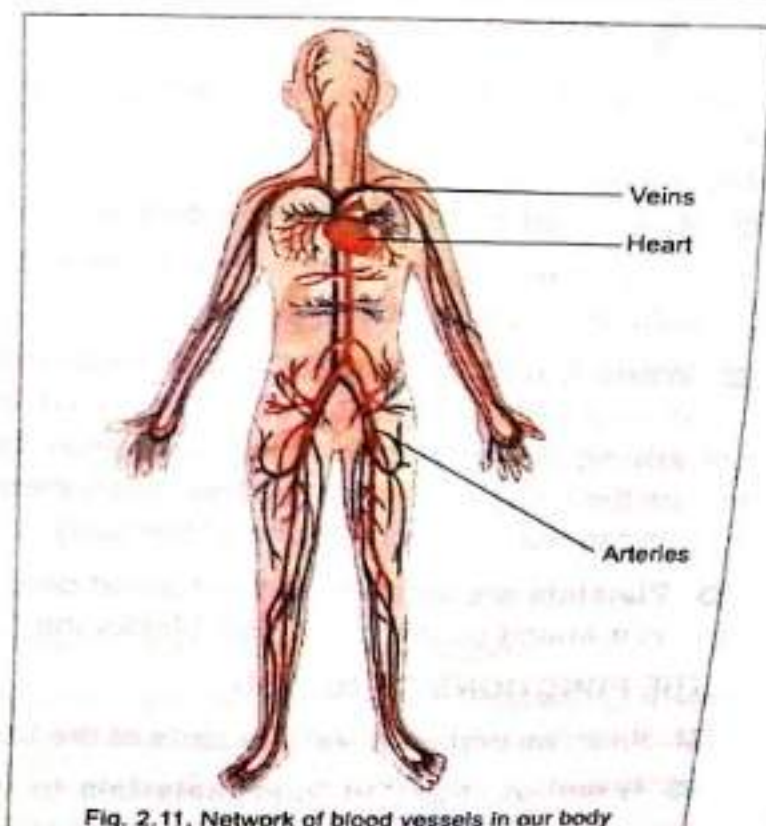


Fig. 2.11. Network of blood vessels in our body

shows the network of blood vessels in human body. The blood enters the right side of the heart and is pumped to the lungs where it gives up carbon dioxide and picks up oxygen. This oxygen-rich blood travels back to the left side of the heart. It is again sent to all parts of the body and the process is repeated again and again. This process outlines the working of the circulatory system.

THE BLOOD: Blood is a liquid tissue. The human body contains 3-5 litres of blood. It consists of a fluid known as **plasma** in which three types of **blood cells** float.

PLASMA: Plasma is the liquid part of the blood. It is yellowish in colour and contains about 90 per cent water. It has food, wastes, enzymes, etc. dissolved in it. It also contains proteins that help the blood to clot.

BLOOD CELLS: There are three types of blood cells (Fig. 2.12).

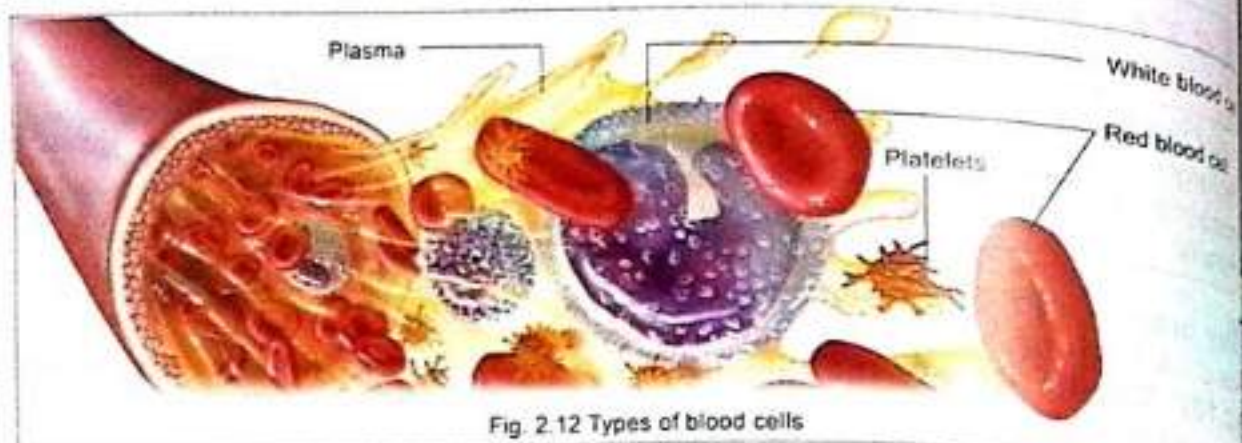


Fig. 2.12 Types of blood cells

- ❑ **Red blood cells (RBCs)** are disc-shaped cells. They contain a red-coloured protein called **haemoglobin**. It is this pigment that absorbs oxygen and transports it to all cells all over the body.
- ❑ **White blood cells (WBCs)** are slightly larger than red blood cells. They are fewer in number than red blood cells. **Their main job is to fight against diseases by killing harmful bacteria and other foreign material.** They are able to move on their own like *Amoeba*. This helps them to pass through the walls of blood vessels and to reach infected parts of the body.
- ❑ **Platelets** are smaller than red blood cells. They help the blood to clot whenever there is a wound on the body. This blocks the flow of blood and prevents blood loss.

THE FUNCTIONS OF BLOOD

- ❑ It carries oxygen to various parts of the body.
- ❑ It carries digested food materials to various parts of the body for distribution.
- ❑ It transports hormones and a number of other substances.

- It helps in preventing excessive bleeding by forming blood clot.
- It helps in maintaining a constant body temperature.
- It protects the body against invading germs.
- It transports waste materials to the excretory organs for excretion.

Let's work in team!



Search and write facts about universal donors of blood and universal recipients of blood. See if you can find the names of people who are donors and recipients.

Good to know

BLOOD TRANSFUSION: A badly injured person may lose a lot of blood. A blood loss of 40 per cent or more can cause death. The doctor must give the patient blood donated by another person (called a donor) to make up for the blood loss. This procedure is called blood transfusion. Donated blood is stored in blood banks after careful testing.

There are four kinds of blood groups known as **A, B, AB and O**. Different persons have different blood groups. Blood of one group does not match with others. Doctors have to be careful to match the blood of the patient with that of the donor before carrying out blood transfusion. This is because if the blood of unmatched groups gets mixed, the red blood cells stick together and it can lead to death.

THE EXCRETORY SYSTEM

During life activities such as cellular respiration, several chemical reactions take place in the body. These are known as **metabolism**. These chemical reactions produce waste products, such as carbon dioxide, water, salts, urea and uric acid. A build-up of these wastes is harmful to the body. The excretory organs remove these wastes. **This process of removal of metabolic wastes from the body is known as excretion.**

Excretion in animals

In lower animals such as *Amoeba*, *Paramecium*, *Hydra* and sponges, there are no special excretory organs and waste products such as ammonia are excreted by the process of diffusion through the body surface.

Larger animals have special organs for excretion—such as tubular structures called nephridia in earthworms and leeches, malpighian tubules in insects and kidneys in vertebrates.

Organs of excretion in humans

Excretion in humans is carried out by the lungs, skin and the urinary system.

- The **alveoli** in the lungs collect carbon dioxide from the blood, which is given out when you exhale. The lungs also give out some excess water in the form of water vapours.
- The **skin** is richly supplied with blood vessels. As the blood flows in capillaries near the skin, water, salts and other wastes diffuse out from the blood into

the **sweat glands**. These wastes then leave the body as sweat through tiny pores in the skin.

Sweat consists of water, salts and urea. As sweat evaporates, it helps to keep our body cool in summers.

- The **urinary system** is responsible for removing most of the wastes from the body in the form of urine. Urine consists of 95% water, 2.5% urea and 2.5% other waste products. The main organs of this system are the **kidneys** (Fig. 2.14). They are located on each side of backbone, just above the waist.

Function of kidneys

The main function of kidney is to filter wastes from the blood. You use a filter paper to separate solid impurities from a solution. The kidneys work in the same way.

The kidneys consist of a large number of coiled tubes called **nephrons**.

The wastes collected in the kidneys form a liquid called **urine**. It passes from the kidneys through two tubes called **ureters** into an elastic sac called the **urinary bladder**. The bladder stores the urine until it is excreted from the body through the **urethra**. A human being passes out about 1.5 to 2.5 litres of urine every day. The kidneys must function properly to keep the body healthy.

Excretion in plants

Plants also produce excretory materials in their cells though these are produced much more slowly than in animals. They have no excretory organs to expel them out. The different methods of excretion in plants are as follows:

- The waste gases—carbon dioxide, oxygen and water vapours, produced during respiration and photosynthesis, are expelled through the stomata of leaves and lenticels of stems.



Fig. 2.13 Internal structure of skin

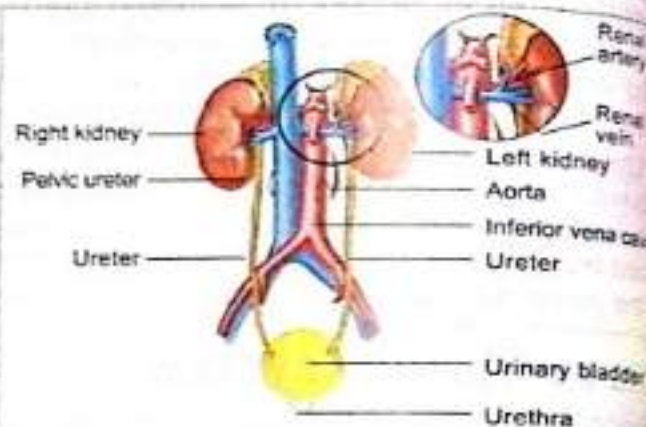


Fig. 2.14 The human urinary system

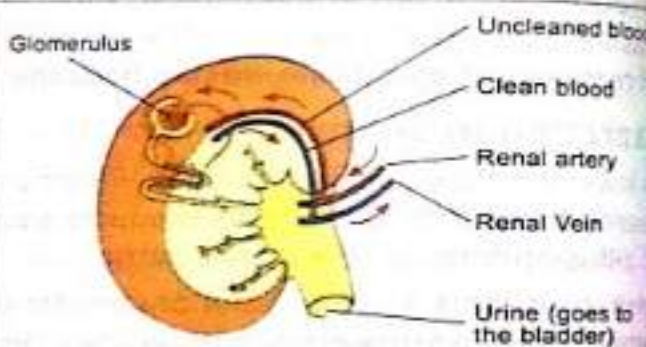


Fig. 2.15 Internal structure of human kidney

- Other waste products are converted into insoluble compounds which remain in the cells. When dead leaves, bark or any other parts fall off a tree, the waste products they contain are also removed. Some plants release waste products from their stems, these wastes including resin, gum and latex.



Fig. 2.16 Latex is an excretory product in plants.

Good to know

Several of the plant wastes are useful to us, for example, gums, resins, sandal wood oil, eucalyptus oil, tannin (found in the bark of many trees and used in the tanning of leather), rubber, and alkaloids (very poisonous compounds, some of which, like quinine, morphine, etc. are used as medicines).

Amazing facts!

In the cells of yam (zamikand), needle-like crystals of calcium oxalate (called raphides) accumulate as waste. When you eat yam the burning sensation you often feel in the throat is because of these crystals. If the yam pieces are boiled in water with tamarind in it, the crystals dissolve in the acid present in the tamarind. If the yam is then cooked and eaten, the sensation is not felt.

Let's work in team!



Collect information about the process of kidney dialysis and share it with your classmates.

Teacher's corner



Inform students about recent developments in medical sciences such as bone marrow, kidney and heart transplant.

KEY POINTS

Here is a list of key points to remember:

- 🔑 In living organisms, food, oxygen, waste products, etc. have to be transported from one part of the body to another.
- 🔑 In unicellular organisms, transport occurs by diffusion.
- 🔑 In plants, water and minerals are transported by xylem tubes. Food material is transported by the phloem cells.

- 🔑 Diffusion is the movement of molecules of solute particles from a solution where they have a higher concentration to a solution where their concentration is low.
- 🔑 Osmosis is the movement of a solvent, usually water, from a region of its higher concentration towards the region of its lower concentration through a semi-permeable membrane.
- 🔑 Transpiration is a process by which plants lose water as water vapour into the atmosphere.
- 🔑 Translocation is the movement of dissolved food through phloem tissues of plants.
- 🔑 In humans, the transport of materials occurs through the blood. Blood is pumped by the heart and circulated to all parts of the body through blood vessels.
- 🔑 Blood consists of the liquid plasma with red blood cells, white blood cells and platelets floating in it.
- 🔑 Excretion refers to the removal of metabolic waste materials produced in the body.
- 🔑 In lower animals, excretion occurs by diffusion. Higher animals have special organs for excretion.
- 🔑 Excretion in humans occurs from lungs (carbon dioxide and water vapour), skin (sweat) and the urinary system (urine).
- 🔑 The kidneys in the urinary system filter wastes from the blood. They are excreted from the body in the form of urine.
- 🔑 In plants, waste gases and water are excreted from the stomata and lenticels. Other waste products are excreted along with leaves, bark, etc. when they fall off.
- 🔑 Some plant wastes are used in medicines and industries.

KEY WORDS

Meristematic tissues:	tissues which are found on tips of plants and made up of living and dividing cells.
Piliferous:	having hairs.
Confined:	restricted in one area.
Cuticle:	water proof waxy layer of leaf etc.
Parenchyma:	soft tissues of plants.
Semi permeable:	that only allows selective movement through it.
Atrium:	small chamber.
Invading:	entering.

Sandal wood: a kind of sweet smelling wood.

Yam: a kind of vegetable.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Discuss the importance of transport of various materials in the body.
2. In what ways are xylem and phloem important for transport in plants?
3. Define and explain the process of transpiration.
4. Briefly describe, diffusion, osmosis and translocation.
5. Explain how the water is transported into the plant. Draw a diagram to show the movement of water through roots of a plant.
6. Which system is responsible for transport in humans? Name the organs that constitute this system.
7. Define arteries and veins. What is the importance of capillaries in the circulatory system?
8. Name the constituents of blood. Discuss the importance of each constituent.
9. Enlist the functions of blood in human beings.
10. Define metabolism and excretion. Why is excretion important?
11. Discuss and draw a labelled diagram of the urinary system showing its various organs.
12. How do plants excrete various kinds of waste products?

B. Fill in the following blanks:

1. Transport of nutrients in unicellular organisms occurs by
2. A, B, AB and O are the four kinds of found in humans.
3. In lower animals, excretion occurs by from the body surface.
4. The human heart consists of chambers.

5. In plants, transport of water and mineral salts takes place through
transport of food through
6. The present in red blood cells transports oxygen by combining with it
form
7. The main job of blood cells is to destroy harmful bacteria.
8. Osmosis is the movement of
9. Plasma contains percent of water.
10. The urinary system consists of two, a urinary, ureters
a

C. Write TRUE/FALSE for the statement given below:

1. Digested food, oxygen and carbon dioxide can pass through the walls of the capillaries.
2. Urea is a waste product formed during the digestion of food.
3. The only function of sweat is the excretion of waste products from the body.
4. Plants convert waste products into soluble compounds and then excrete them.
5. In a healthy man, the heart beats about 90 times per minute.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Give one-word answers of the following questions:

1. Through which process is the food from the leaves transported to all parts of a plant?
2. Which tissue is responsible for the transport of materials in human body?
3. In human heart, which chambers have thicker walls—the auricles or the ventricles?
4. Which protein of red blood cells is responsible for the transport of oxygen?
5. You do not fall ill every time harmful bacteria enter your body because certain cells in body can kill the bacteria. Name the cells.
6. Name the tiny filtering tubes in the kidneys.

1. The blood vessels that carry deoxygenated blood in the human body are:

- arteries.
 - veins.
 - capillaries.
 - any of these
- Which of these is responsible for blood clotting?
 - red blood cells
 - white blood cells
 - haemoglobin
 - platelets
- Which of these is not considered as an organ of excretion in humans?
 - skin
 - urinary system
 - lungs
 - anus
- In the human urinary system, which of these, in your opinion, is the most important organ?
 - kidneys
 - ureters
 - urinary bladder
 - urethra
- When you feel your pulse, what you actually feel is blood rushing through the:
 - arteries.
 - veins.
 - capillaries.
 - all of these

Prepare a power point presentation on the working of heart as well as transport of water in plants and deliver it in the class.

Study about different blood groups and their donors and recipients. Apply your knowledge to your classmates to find who can or cannot donate blood to whom.

Control and Coordination

Learning Objectives

At the end of this unit, students should be able to:

- understand and define stimuli and response.
- list major organs of the nervous system.
- write the functions of major parts of the nervous system.
- understand and explain the transmission of message to and from the brain.
- understand the need for coordination.
- name the five senses and sense organs and explain how these senses help in adaptation to environment.
- explain coordination in plants.
- explain movement in plants and animals.
- name major bones in the skeletal system.
- describe the functions of the skeletal and muscular system.

RESPONSE TO STIMULI AND COORDINATION

Multicellular organisms, both plants and animals, have different organs for doing specific jobs. There must be something that regulates all these organs, for example, when you are in a race, your legs move faster. But the movement of the legs alone cannot keep you running. You need extra energy to run. Your breathing rate must go up because you need more oxygen for oxidising food to generate energy. The heartbeat must go up as more blood needs to be pumped to take the extra oxygen and nutrients to the cells. The rate of sweat production must increase, so that the excess heat generated may be lost by evaporation of sweat. These processes work together during the process of running and it is called coordination in living organisms.

Coordination between the different organs and systems is also necessary to cope with changes in our external environment. All organisms react to situations in order to survive through proper coordination. A situation that makes an organism react is known as a **stimulus (plural: stimuli)**. The reaction to the situation is called a **response**. All organisms come across a variety of stimuli. Their reaction to the stimuli varies according to the nature of the stimuli. However, even for the same stimulus, the reaction may vary from time to time and from organism to organism.

Types of stimuli

Stimuli are of two types—external and internal. External stimulus is provided by environmental factors, such as heat, cold, water, wind or other animals. For example, if the weather is very hot, it acts as an external stimulus for organisms to protect themselves from the heat. It could be due to other organisms also. The sight of a dragonfly provides a stimulus to a frog. Its response is to catch the dragonfly and eat it. The response

of the dragonfly will be to try to fly away to protect itself (Fig. 3.1).

Internal stimulus arises from within the organism. For example, excess secretion of hormones or enzymes and an abnormal functioning of some organs of the body provide internal stimulus.



Fig. 3.1 The response of the frog is to try to catch the dragonfly and the response of the dragonfly is to fly away.

Types of responses

There are two main ways in which an organism responds to an external stimulus. For example, if you accidentally touch a hot object, the first response is the quick withdrawal of the hand. This response is spontaneous and is done without thinking.

Such response is called an involuntary response. This kind of response is also called a reflex. Thereafter, you will examine the hand to see how badly it is burnt and take remedial action like putting it in cold water and applying a medicine. This is called the **modified** response. This response is voluntary and done with thinking.

In the 1890s, a Russian scientist named **Ivan Pavlov** studied dog's behaviours. He observed that when a hungry dog smells food, its mouth begins to water. This was a reflex response. The stimulus was food and the response was increased production of saliva. As an experiment, Pavlov rang a bell each time the dog was fed. After doing this for many times, he rang the bell without giving food to the dog. The dog's mouth began to water when the bell was rung, even though no food was present. The dog had begun to associate the ringing of the bell with food and responded accordingly. This type of response is known as **conditioned response**.

Unlike animals, the responses are not always distinctly visible in plants. They are quick and visible only in a few plants such as the 'touch-me-not' plant whose leaves shrivel up on being touched. The Kachnar plants fold their leaflets in the evening and open up in the morning.



Fig. 3.2 Touch-me-not plant

Coordination in human beings

Like plants and animals, human beings also carry out coordination between various parts of the body for various purposes.

Two systems in the human body carry out this job of coordination, the **nervous system** and the **endocrine system**.

These systems work very closely with each other.

THE NERVOUS SYSTEM: The nervous system can be thought of as the body communication system.

Following are the features of nervous system:

- ❑ It receives information from the environment and from various parts of the body.
- ❑ It records this information and sends messages to different parts of the body, instructing them to perform certain functions. This develops response. The nervous system consists of the following components:
- ❑ The **central nervous system** consists of **brain** and **spinal cord**.
- ❑ The **peripheral nervous system** consists of **nerves** which link the central nervous system with the various body organs.

The nervous system (Fig. 3.3) is made up of nerve cells known as **neurons**. They are the smallest structural and functional units of the nervous system (Fig. 3.4). Each nerve cell consists of:

- ❑ the cell body or **cyton**.
- ❑ finger-like extensions arising from the cell body called **dendrites**.
- ❑ A long tube-like part called the **axon**, enveloped in a sheath called **myelin sheath**.

Neurons are the longest cells in the human body. They are up to a few centimetres long. Neurons join together to form nerves.

BRAIN AND ITS PARTS: It is a very complex and delicate organ. It is protected by the bony skull. It has three main parts—the **cerebrum**, the **cerebellum** and the **medulla oblongata** (or brainstem) (Fig. 3.5).

Good to know

The human being is made up of about 100 billion neurons.

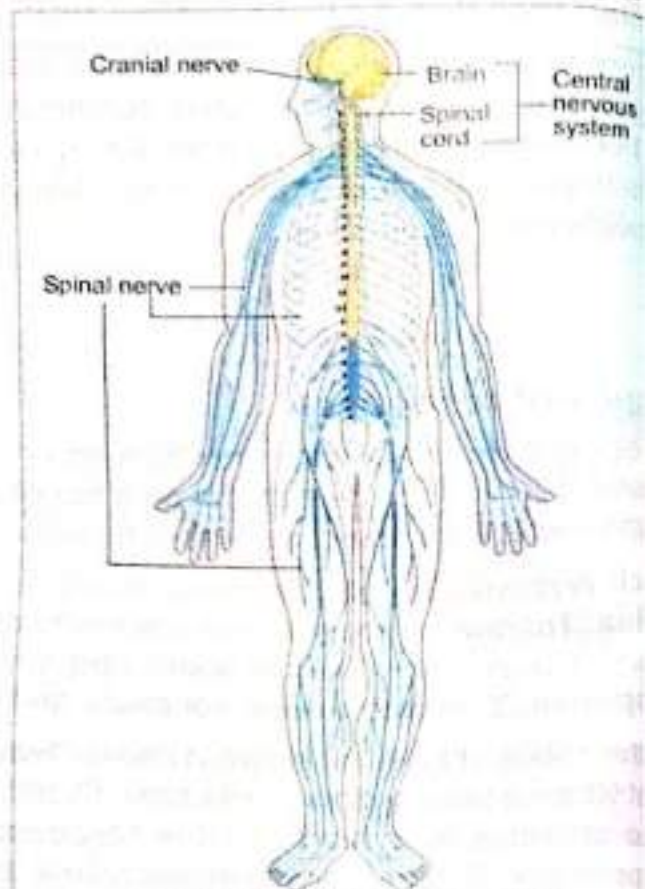


Fig. 3.3 The human nervous system

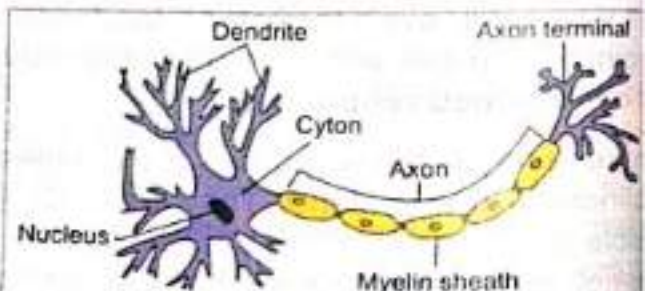


Fig. 3.4 Billions of neurons form the nervous system

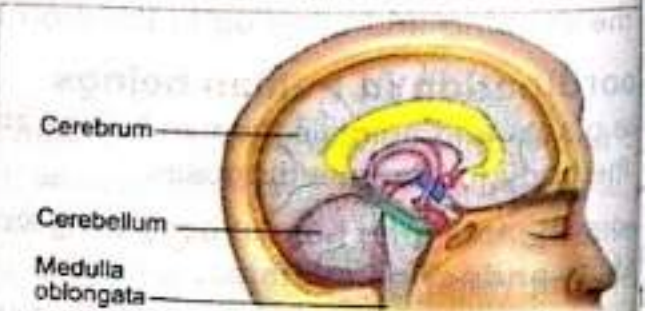


Fig. 3.5 The side view of human brain

These different regions of the brain carry out different functions.

THE CEREBRUM: The cerebrum, the largest part of the brain, performs the following functions:

- ☐ It is the body's thinking and control centre.
- ☐ It receives messages from the sense organs and gives responses.
- ☐ It controls memory and learning.

Good to know

Hippocampus is the part of brain which stores long term memory. If it is damaged somehow, the person's short term memory is lost after short time, this means everything he experiences, just vanishes after sometime.

THE CEREBELLUM: The cerebellum is situated towards the back of the brain, below the cerebrum. Its functions are as follows:

- ☐ It maintains the body's balance.
- ☐ It controls and coordinates the muscles to perform voluntary actions like walking, talking and feeding.

THE MEDULLA OBLONGATA: The medulla oblongata forms the lower portion of the brain. It narrows down to join the spinal cord. It controls all involuntary actions, i.e. muscular actions that occur on their own, for example, the muscular activities of the internal organs such as beating of the heart.

THE SPINAL CORD AND NERVES

The spinal cord is a tube-like extension of brain and forms the main link between the brain and the rest of the body. It also controls reflex actions. It is attached to the medulla oblongata and runs down the middle of the back. It is protected by the vertebrae of the backbone. **Nerves branch out from the spinal cord to all parts of your body.** They branch out many times forming smaller and smaller nerves, so that every corner of the body is supplied with neurons.

Messages travel from the brain, down the spinal cord, through the nerves, to all parts of the body. Nerves that transmit messages from the brain to all parts of the body are known as **motor or efferent nerves**. Incoming messages from the sense organs enter the spinal cord through the nerves and then travel up to the brain. The nerves that carry these messages to the brain are known as **sensory or afferent nerves**. Nerves of spinal cord and brain are called spinal and cranial nerves respectively.

The sense organs

Information about the environment is received by organs called **receptors**. Humans have five receptors referred to as **sense organs**—eyes, ears, nose, tongue and skin. Each sense organ is designed to receive a certain kind of stimulus. When a sense organ receives

a stimulus, it sends an impulse to the brain. The brain interprets this impulse. You can see, hear, smell, taste or feel your environment.

THE EYES: Eyes are the organs of sense of sight. Eyes have a complex structure. The lens in the eye forms an image of an object on the retina. The retina is a sheet of light-sensitive neurons. When they get stimulated by light, they send impulses along the optic nerve to the brain that sees the image. Fig. 3.6 shows the internal structure of human eye.

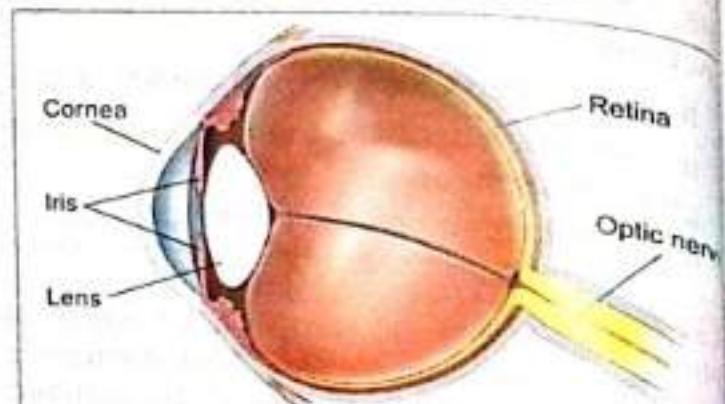


Fig. 3.6 The internal structure of human eye

THE EARS: The ears are the organs of hearing. The neurons in the inner ears receive sound waves and convert them into impulses that travel to the brain. The brain interprets these impulses as the sounds you hear. Different sounds produce different vibration patterns in the ear.

Ears also play an important role in maintaining the body balance.

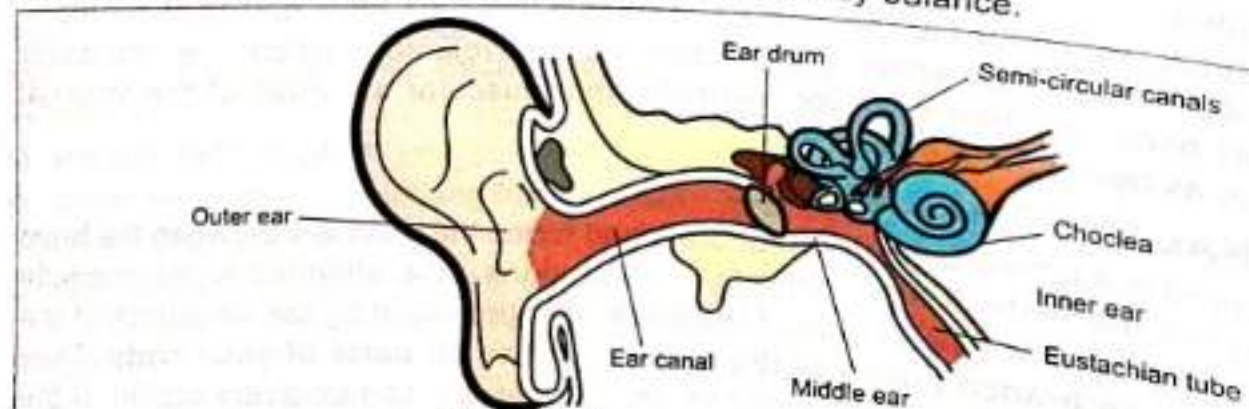


Fig. 3.7 The internal structure of human ear.

THE NOSE: The nose can detect smell. Smells are actually chemical substances that diffuse through air. Neurons in the upper part of your nose detect these substances and send impulses to the brain. The sense of smell in other vertebrate animals such as dog is much highly-developed than humans.

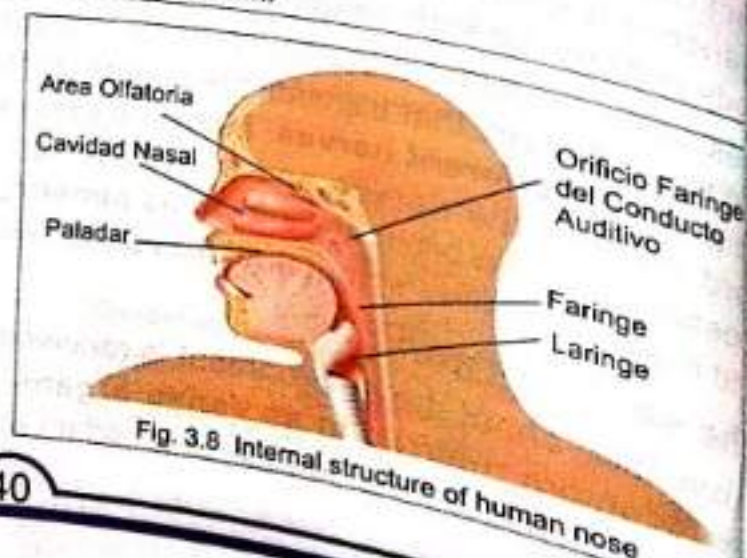


Fig. 3.8 Internal structure of human nose

Table 3.1 Location and functions of some organs of the human nervous system

Organ	Location	Its parts	Functions
brain	in the skull	cerebrum cerebellum medulla oblongata	It controls your thinking, hearing smelling, memory and learning. It controls muscular coordination and balance of the body. It controls involuntary muscle movements like breathing and heartbeat.
spinal cord	attached to medulla oblongata, and runs through the vertebral column		It connects the brain to the rest of the body. It also controls the reflex actions.
nerves	branch out from spinal cord and brain to all parts of the body	sensory or afferent nerves motor or efferent nerves	They perceive stimuli and transmit it to the brain. They carry messages from the brain to all parts of the body.
sense organs	different location	eyes, ears, nose, skin, tongue	They provide information of the external environment.

THE TONGUE: The tongue is the organ that helps to detect taste. The tongue contains elongated cells called **taste buds**. They help to taste the four basic tastes-sweet, salty, sour and bitter. Each taste is detected by different taste buds located at different places on the surface of the tongue.

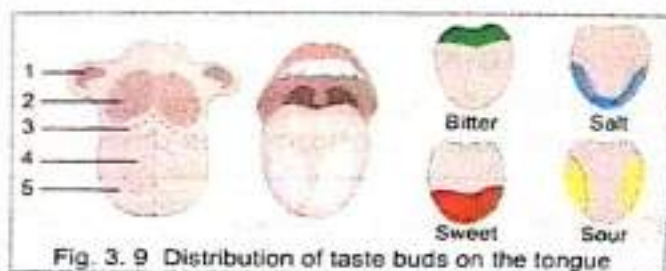


Fig. 3.9 Distribution of taste buds on the tongue

Good to know

It was previously thought that sweet, sour, bitter, and salty tastes are felt at different places on tongue. However, recent studies have proved that tongue can feel all these tastes more or less equally.

THE SKIN: The skin is a sense organ that responds to five different stimuli. They are touch, pressure, pain, heat and cold. The neurons in the skin are not clustered together into an organ as in case of other sense organs. Instead, they are scattered throughout the skin. They are, therefore, called **free receptors**. When the sensory neurons in the skin are stimulated, an impulse is sent to the brain. The brain then interprets the impulse as one of the five skin sensations.

THE ENDOCRINE SYSTEM

The coordination which is carried out by endocrine system is called chemical co-ordination because it is brought about by chemicals called hormones.

The endocrine system consists of a number of glands which release substances called **hormones** into the blood. Hormones regulate many functions in the body. Each hormone is required in very small quantity and has its own specific function. Hormones control growth, development, behaviour and reproduction. Glands that produce hormones are located in various parts of the body (Fig 3.10). There are nine major endocrine glands in human body. Some of them are as follows:

- ❑ Adrenal glands secrete the hormone **adrenalin** when a person is angry or afraid. It prepares the body to fight or flight.
- ❑ Pancreas secretes the hormone **insulin**, which regulates the amount of sugar in the blood.

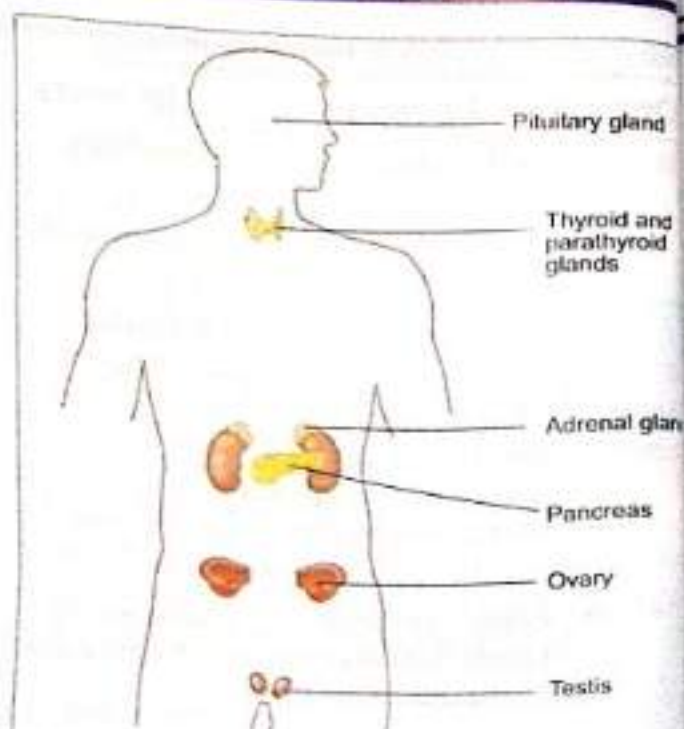


Fig. 3.10. The endocrine system in humans

Good to know

The name 'endocrine' means 'ductless'. This name is given to these glands because they release their hormones directly into blood without ducts or tubes.

Coordination in plants

Plants do not have a nervous system and coordination takes place only by means of hormones. Therefore, it is called chemical coordination. For example, the branches in trees grow in such a way that the form or the shape of the tree is maintained. This coordination in growth is brought about by various hormones called **phytohormones**.

ACTIVITY TIME! To show that stem grows towards light.

Place a potted plant near an open window through which light is coming in and observe it after a few days.

You will find that the stem bends towards the window which means towards light (Fig. 3.11).

This movement occurs because of hormones called **auxins**. The common plant hormones and their roles are explained in Table 3.2. One kind of plant auxin stimulates the growth of cells. If a plant gets light from only one side, the auxin moves away from the lighted side of the stem.



Fig. 3.11 Plants grow towards light. (phototropism)

Table 3.2 Plant hormones and their functions

Hormones	Functions
auxins	stimulate growth
cytokinins	stimulate cell division
gibberellins	stimulate growth, stem elongation, germination of seeds, etc.
ethylene	stimulates fruit-ripening, root formation, etc.

The concentration of auxin increases on the shaded side of the stem. This causes the cells to grow faster on the shaded side than on the lighted side. The unequal growth rate causes the stem to bend towards the light. This behaviour of plants to grow towards light is called **phototropism** (Fig. 3.11).

In a plant, the shoot always grows up, while the root always grows down. You can test this by taking a potted plant and tilting it. You will find that after a few days, the stem changes its direction to grow up, whereas the root changes its direction to grow downwards (Fig. 3.12). This is called **geotropism**. It is affected by the gravity of the earth and is also controlled by auxins.



Fig. 3.12 Roots grow towards gravity and shoots grow away from it.

ACTIVITY TIME! To prove that the stem grows against gravity.

Take a flowering plant growing in a pot. Place the pot sideways for a few days. You will find that the stem of the plant bends and grows vertically upwards. This shows that the stem always grows vertically (Fig. 3.13).



Fig. 3.13 The stem grows vertically upwards.

LOCOMOTION (MOVEMENT)

Animals move about mainly in search of food and shelter. Plants manufacture their own food, and hence, they do not have to go from place to place to procure it.

Movement in plants

Unlike animals, plants do not move from place to place using their muscles. However, the organs show different types of movements as responses to different stimuli. You have already seen movement of the stem towards light, root towards gravity and stem away from gravity. Such a response, which a plant makes to an external stimulus, such as light, gravity and water is known as **tropism**.

- ❑ The stem of a plant is **positively phototropic**, i.e. it grows towards light. The root is **negatively phototropic**, i.e. it moves away from light.
- ❑ The root is **positively geotropic**, i.e. it grows towards gravity. Stem is **negatively geotropic**, i.e. it grows away from gravity.
- ❑ The root grows towards water, i.e. it is said to be **positively hydrotropic**.

There is another type of movement in plants. The leaves of plants like *Oxalis* or *Clover* open during the day and close at night. In some plants belonging to the pea family, the leaflets open during the day and close at night. This type of movement is known as **sleep movement**.

In some insectivorous plant, like pitcher plant, the lamina of leaf is modified into a pitcher-like structure (Fig. 3.16). The lid of the pitcher moves on touching to close it. Movement in plants is, however, slow and cannot be easily seen.

Movement in animals and other organisms

Movement in animals is faster and of many different types. Animals possess two kinds of movement—locomotion and movement of body parts. Locomotion in animals help them to find food and shelter, to shift from an unfavourable environment to a favourable environment, to escape from predators, to find mates for reproduction and to find suitable places for laying eggs or giving birth to babies and rearing their young ones.

Different organisms use different organs for locomotion:

- ❑ *Amoeba* moves slowly by extending one or more pseudopodia from its unicellular body. This is known as **amoeboid motion**.



- ❑ *Paramecium* uses the cilia present on its body for swimming in water. This is known as **ciliary motion**.
- ❑ *Euglena* has a long thread - like structure called flagellum which it uses for movement. This is known as **flagellar motion**.
- ❑ Most animals use muscles or both muscles and bones for locomotion. This type of motion is known as **muscular motion**. The earthworm alternately expands and contracts its muscles to move forward (Fig. 3.18). It has stiff hair-like projections called **setae** to grip the ground and enable the expansion and contraction of the muscles to move its body forward.
- ❑ Animals such as insects, crabs and spiders have jointed legs. They are known as **arthropods**. They have a hard and tough protective covering over their body, known as an **exoskeleton**. The body muscles are attached to the exoskeleton and enable movement at the joints. Flying insects such as mosquitoes and houseflies have wings to fly. Muscles attached to the exoskeleton control the movement of the wings.
- ❑ The vertebrates (i.e. the animals with backbone) including humans use muscles and bones for locomotion. Vertebrates have a hard skeleton inside their bodies called an **endoskeleton**. It is made up of bones. Vertebrates also have a well developed muscular system. The fish uses fins and tail muscles to swim. The snake has no legs, yet it can move fast. It uses its scales and ribs to crawl. Birds use wing muscles to flap their wings up and down to fly. Similarly, humans use their limbs and muscles for locomotion.



Fig. 3.17 Amoeboid movement

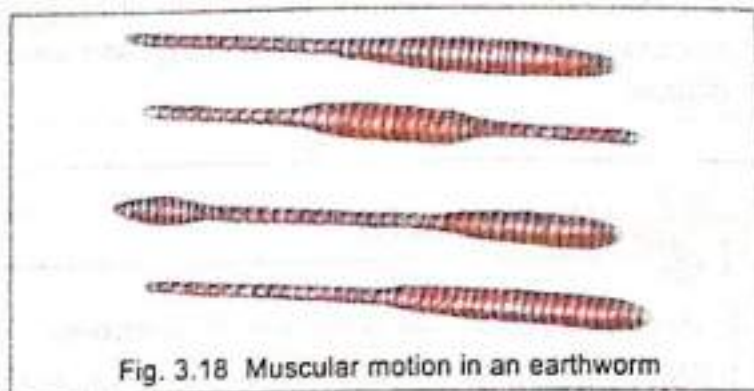


Fig. 3.18 Muscular motion in an earthworm

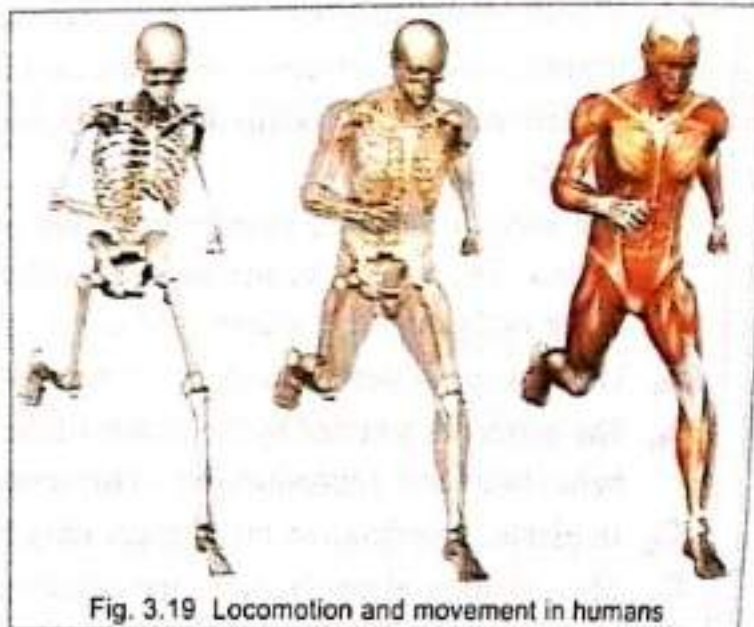


Fig. 3.19 Locomotion and movement in humans

have stopped. This sends a message to the brain that you are still spinning. However, your eyes report to the brain that you have stopped! The confusion created in the brain leads to a dizzy feeling.

Let's work in team!



Divide students into five groups. Each group is to deliver a power point presentation about any one sense organ of human body, describing its working and related diseases.

Teacher's corner



Deliver a multimedia presentation in which inform students about the reflex actions of a human body.



KEY POINTS

Here is a list of key points to remember:

- 🔑 A situation that makes an organism react is known as a stimulus. The reaction to the situation is called a response. The two main kinds of responses are reflex and modified.
- 🔑 Stimuli are of two types— external and internal.
- 🔑 The life activities of animals are coordinated by the nervous system and the endocrine system.
- 🔑 The human nervous system consists of brain, spinal cord, nerves and five sense organs. The sense organs provide information, the brain controls all the functions of the body, and the spinal cord and nerves transmit messages to and from the brain.
- 🔑 The nervous system is made up of nerve cells called neurons.
- 🔑 The hormones secreted by the glands of the endocrine system control growth, development, behaviour and reproduction. This coordination is called chemical coordination.
- 🔑 In plants, coordination takes place only by hormones.
- 🔑 Movement in plants is slow, and occurs in response to light, gravity, etc.
- 🔑 *Amoeba*, *Paramecium* and *Euglena* move by means of pseudopodia, cilia and flagella, respectively.
- 🔑 Most animals use muscles, or muscles along with bones for movement. Their movement is known as muscular movement.
- 🔑 In humans, the skeleton moves at the joints with the help of muscles.

KEY WORDS

Stimulus: a change in environment that causes a response.

Coordination: the process of working of different body parts together for some

specific purpose.

Peripheral: surroundings/sideways.

Optic: related to eye.

Impulse: something that causes something else to happen.

Retina: the innermost sensitive layer of eyeball.

Voluntary: under body's control.

Involuntary: done without conscious control.

Phototropic: moving towards light.

Geotropic: moving towards gravity.

Pseudopodia: a finger-like projection in *Amoeba* that helps in locomotion.

Cilia: tiny hair-like structures that help *Paramecium* in locomotion.

Flagella: long thread-like structures that help unicellular organisms in locomotion.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Use an example to discuss the importance of coordination in human body.
2. Why is the nervous system regarded as the communication system of the body?
3. What are the different parts of our brain? What functions does each perform?
4. What is the main difference between the skin and other sense organs?
5. What are hormones? Name some important plant and human hormones and their functions.
6. What do you know about phototropism and geotropism in plants?
7. What is the difference between endoskeleton and exoskeleton. Also give example.
8. What are the movements in *Amoeba*, *Paramecium* and *Euglena* called?

B. Fill in the following blanks:

1. The two types of stimuli are and
2. The nerves carry messages from the brain to other parts of the body.
3. In plants, hormones called regulate growth that cause movement.
4. The stem of a plant is phototropic whereas the root is phototropic.

5. Movement in human body occurs when pull on
6. Impulses from the eyes go to the brain through the nerves.
7. The glands of the endocrine system secrete substances called
8. Movement occurs at joints due to contraction and expansion of
9. A skeleton is made of

C. Write TRUE/FALSE, which one is possible for the given statements:

- | | TRUE | FALSE |
|--|--------------------------|--------------------------|
| 1. In plants, coordination is carried out by the nervous system. | ☐ | ☐ |
| 2. The skeleton also helps in the movement of the body. | ☐ | ☐ |
| 3. The nervous system is made up of millions of nerve cells, known as neurons. | ☐ | ☐ |
| 4. Information about the environment is received by organs called hormones. | ☐ | ☐ |
| 5. The tongue contains elongated cells called taste buds. | ☐ | ☐ |

D. Give one-word answers of the following questions:

1. In animals, does the nervous system alone carry out the function of coordination and control?
2. Which kind of specialized cells are the brain, spinal cord and nerves made up of?
3. Which part of the nervous system is protected by the vertebrae of the backbone?
4. Which part of the nervous system controls reflex actions—brain or spinal cord?
5. Is a conditioned response inherent or learnt?
6. Which part of the nervous system contains the brain and spinal cord?
7. Which sense organ has sensory neurons scattered all over the body surface?
8. Which part of the nervous system generates the response in a reflex action?
9. Name the plant movement which is performed as a response to the stimulus of light.
10. Name the organs of locomotion in the following:

- | | | |
|-----------|-----------|---------------|
| a. Fish | b. Birds | c. Frog |
| d. Amoeba | e. Snakes | f. Paramecium |

E. Choose the most appropriate answer for the following statements:

1. Which of the following can be thought of as the body's communication system?

a. digestive system	b. excretory system
c. nervous system	d. circulatory system

2. Which of the following controls fruit ripening?

- a. auxins
- c. cytokinins

- b. gibberellins
- d. ethylene

3. Which of the following is not an endocrine gland?

- a. kidney
- c. pancreas

- b. thyroid
- d. testis

4. Which of the following is not a plant hormone?

- a. auxins
- c. cytokinins

- b. gibberellins
- d. insulin

Homework Assignment



Study and make a list of animals with extraordinary sense of smell and hearing. Explain their abilities with examples.

WITH SCIENCE

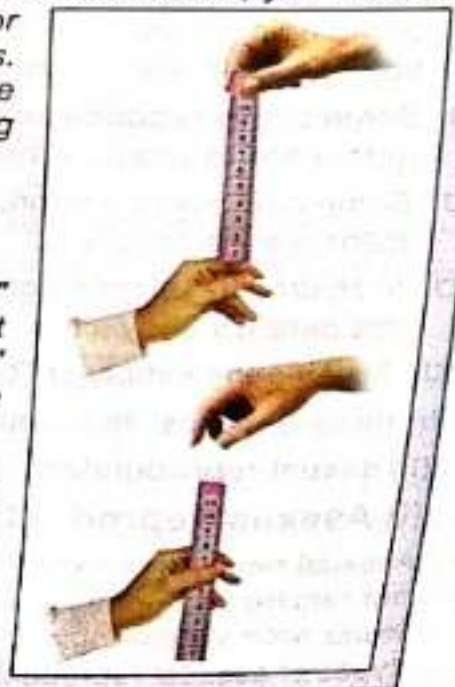
Check response time

You know that signals from your sense organs reach your brain. When the brain wants some action to be taken, it sends an instruction to the muscles. Sometimes, you need to move very fast, for example, to avoid a stone thrown at you, or to catch a ball. Some people have faster responses than others. This simple experiment will enable you to study the response time of people. The response time is the time between sensing something and beginning to move.

You will need • 30 cm ruler

Procedure:

1. Use the inch marks. Hold the ruler from the top at the 12" mark. Ask a friend to keep his thumb and forefinger about 1 cm apart in level with the bottom of the ruler at the 0" mark. Ask the friend to concentrate on his hand and to grip the ruler as you release it.
2. Release the ruler suddenly. As your friend grips the falling ruler, note the inch mark nearest to his forefinger and thumb. This gives an idea of his response time. The closer the mark is to 0, the faster is his response time. Perform this experiment three times and find the average score. Find out the response time of your friends on this at 0-12 scale.



Reproduction and Growth

Learning Objectives

At the end of this unit, students should be able to:

- understand and define reproduction and its types.
- list different modes of reproduction in plants and animals.
- understand reproduction in humans.
- understand and define growth.

All living things ultimately die. All of them have the ability to produce young ones of their own kind. This process is known as **reproduction**. It is because of reproduction that life continues from generation to generation.

All the systems of living organisms described so far are essential for life. If one of these systems were to stop working, the organism would die. But the reproductive system is not necessary for the organism to stay alive. However, without it, the organism cannot produce offspring and, therefore, cannot continue its species. Thus, reproduction is the means of the survival of a species.

REPRODUCTION

There are several methods of reproduction in nature. Some of them are given below:

- Some animals produce babies.
- Some animals lay eggs from which young babies are hatched.
- Some plants produce seeds which germinate to produce new plants.
- Some new plants are produced by bulbs, leaves or tubers.
- In *Hydra*, the offspring grows out of the parent's body.
- An *Amoeba* simply splits into two.



Fig. 4.1 Animals and their babies

In general terms, there are two methods of reproduction: (i) **asexual reproduction** and (ii) **sexual reproduction**.

(i) Asexual reproduction

Asexual reproduction involves the production of new organisms by just one parent. It does not require two opposite sexes. It is mostly found in unicellular organisms as well as in lower animals and plants. There are many forms of asexual reproduction. Some of the types of asexual reproductions are discussed below.

FISSION: Fission refers to division of a cell into two parts. This is the simplest type of asexual reproduction.

asexual reproduction and is seen in single-celled organisms such as *Amoeba* (Fig. 4.2a) and *Paramecium* (Fig. 4.2 b). In **binary fission**, the fully grown parent cell splits into two halves, producing two new cells.

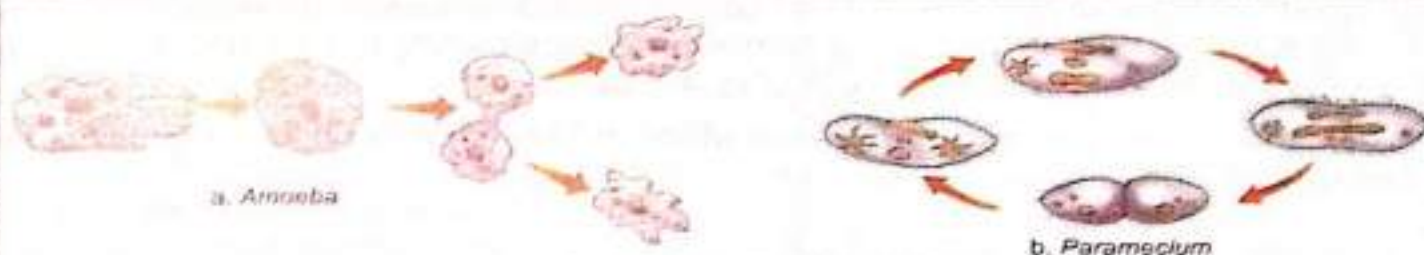


Fig. 4.2 The process of binary fission

During binary fission in *Amoeba*, the nucleus first divides into two equal parts. The cytoplasm also divides into two parts, each part containing a nucleus. The two daughter *Amoebae*, thus formed, grow and attain full size before splitting again.

Sometimes, during unfavourable conditions, a protective coating called a **cyst** develops around the cell. The cell divides within the cyst to produce many daughter cells. When the cyst breaks, several cells are released at once. This is called **multiple fissions** (Fig. 4.3).

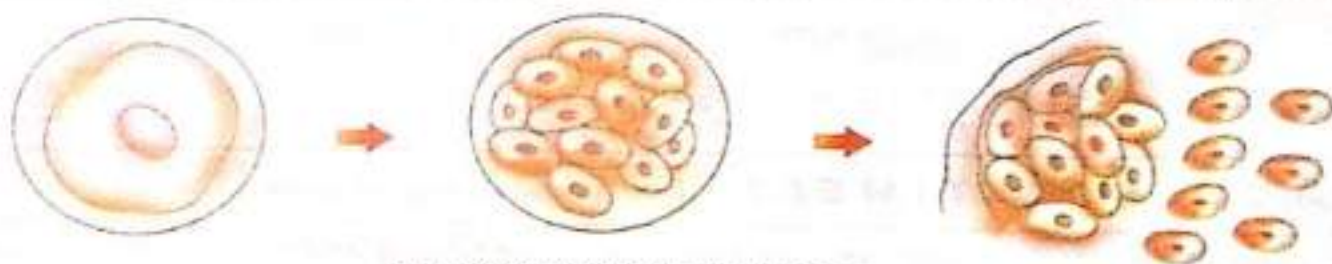


Fig. 4.3 The process of multiple fissions

FRAGMENTATION: During fragmentation in some organisms such as the *Spirogyra* (alga) or a flatworm, the organism breaks up into two or more fragments after maturation (Fig. 4.4). These fragments then grow into new individuals.

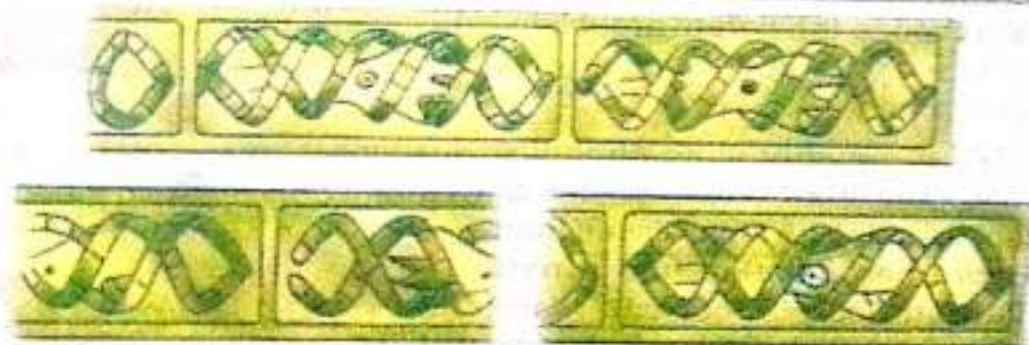


Fig. 4.4 Fragmentation in *Spirogyra*

BUDDING: In budding, a new organism grows from the parent organism in the form of a bulb-like projection called a **bud**. It grows and may eventually break away from the parent. Yeast and *Hydra* reproduce by budding. In yeast, a little cytoplasm accumulates inside a small growth at one end of the cell and a bud is formed. The nucleus divides into two. One of them enters the bud. In yeast, bud formation occurs rapidly to form a chain of yeast cells, if the supply of nutrition is enough (Fig. 4.5 a).

In *Hydra*, a bud appears on the body wall which grows into a full *Hydra* in a day or two and separates from the parent (Fig. 4.5 b).

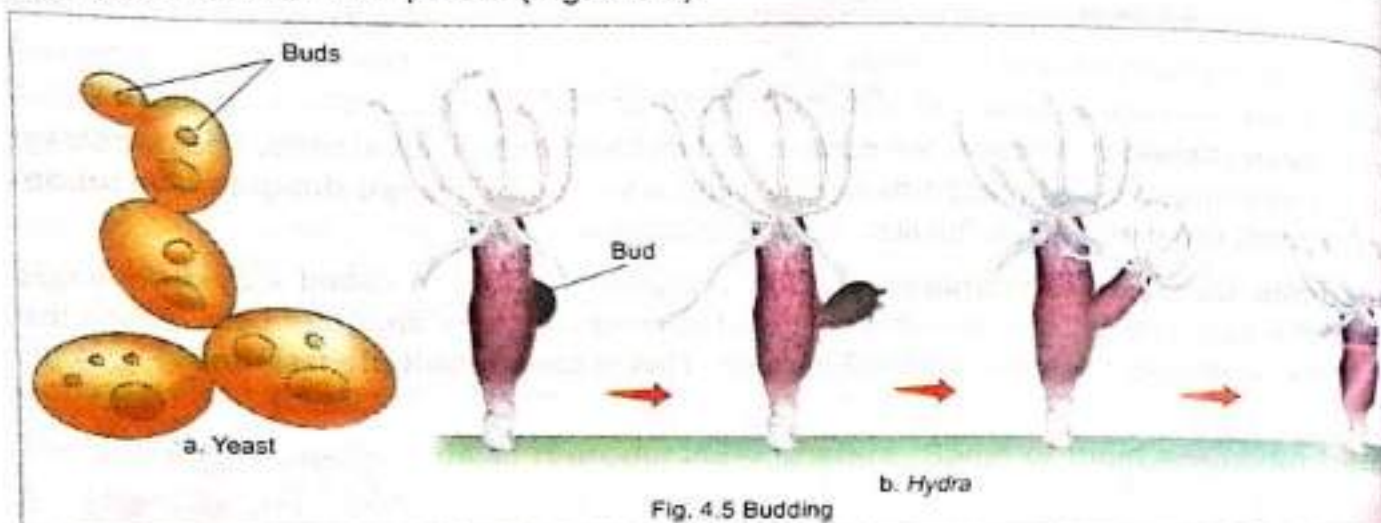


Fig. 4.5 Budding

ACTIVITY TIME! To observe budding in yeast.

Purchase a packet of yeast powder and take about 10 g of yeast. Take warm water in a beaker and dissolve a spoonful of sugar in it. Put the yeast powder in the beaker. Keep the beaker in a warm place. After about an hour, put a drop of the solution on a glass slide and observe it under a microscope. Can you see buds formed on the yeast cells?

In corals and sponges, buds do not separate out but remain attached to the parent organism. They grow to full size and reproduce again and again producing a colony.

REGENERATION: In regeneration, an entire new organism can grow from certain pieces or cells of the parent organism. A small tissue from the body of *Hydra* can develop into a new organism. A flatworm can be cut into many pieces and each piece will grow into a complete flatworm (Fig. 4.6).

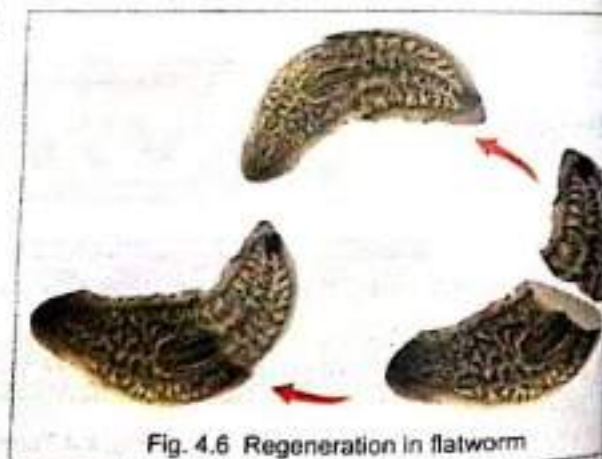


Fig. 4.6 Regeneration in flatworm

Some lower animals such as starfish have the ability to regenerate the lost parts of their bodies.

SPORE FORMATION: A spore is a tiny, spherical, unicellular body protected by a thick wall. It grows into a new plant when conditions are favourable. Plants of lower orders, such as mosses, ferns, moulds etc. reproduce by spore formation. Bread mould that can often be seen growing on moist, stale bread, grows when spores settle on the bread. Higher animals generally do not have this ability.



Fig. 4.7 A starfish can regenerate its lost arm.

ACTIVITY TIME! To observe spores under a microscope.

Take a piece of bread and sprinkle water on it. Keep the bread in a warm, dark place. Keep sprinkling water on it to keep it moist. Observe after two days. Can you see mould growing on it? Observe the shape of the mould with a magnifying glass. You will see fine thread-like projections called hyphae and tiny rounded structures that contain spores. Carefully take one of these with the help of tweezers and place it on a glass slide. Cover it with a cover slip and observe it under a microscope. You will be able to see tiny spores.



Fig. 4.8 Fungal spores under microscope

VEGETATIVE PROPAGATION

When new plants are produced from parts of the mother plant, such as root, stem, or leaves, without the help of any reproductive organs, it is known as vegetative propagation. There are many plants like cacti and strawberry plants that reproduce by growing new plants from the single parent only. Some of them are discussed below.

- Potato is an underground stem tuber. When it is cut into parts and planted in the soil, each part with an 'eye' develops into a new potato plant. Each eye is actually a bud which develops into a new plant under suitable conditions.



Fig. 4.9 Buds in potato

- New plants are also produced by parts of underground stems in ginger (Fig. 4.10 a), and from bulbs in onion (Fig. 4.10 b), lily and tulip. Bulbs are underground stems with thick leaves.

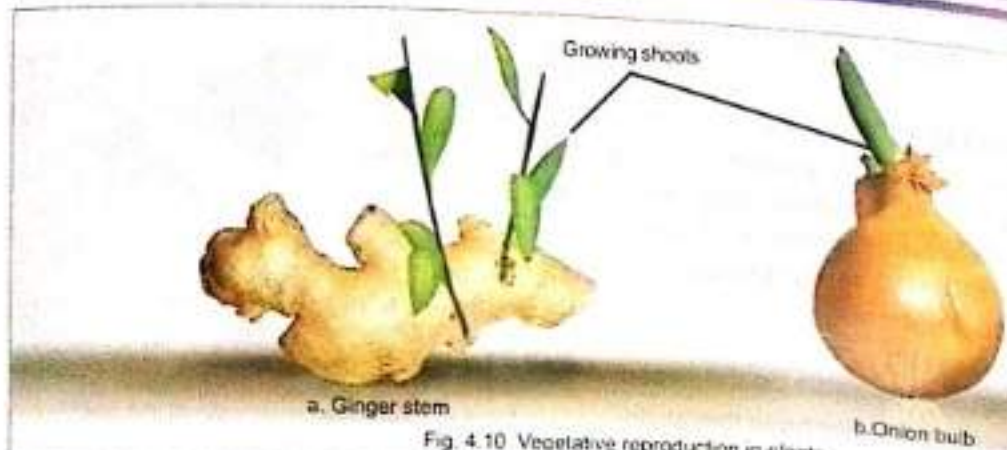


Fig. 4.10 Vegetative reproduction in plants

- ❑ In some plants, such as strawberry and grasses, the main plant sends outside shoots which have buds that grow into new plants (Fig. 4.11). These shoots are called runners.
- ❑ New plants are also obtained from leaves, roots and shoots of some plants. The leaf of *Bryophyllum* has many buds on its margin (Fig. 4.12). These buds give rise to new plants. Sweet potato is grown by cutting its swollen roots into parts and planting them in the soil. In money plant, new plants can grow from shoots of the parent plant.



Fig. 4.11 Strawberry runner



New plant

Fig. 4.12. *Bryophyllum* leaf

Fig. 4.13 Money plant

ACTIVITY TIME! To observe vegetative reproduction in money plant.

Take a small piece of the shoot of a money plant. Plant it in soil in a pot. Observe its growth.

In *Gladiolus*, the stems are short and swollen with stored food. They are called corms and can be separated from each other to form a new plant. In plants, cells of only a specific tissue can divide and therefore, growth occurs only at the places where such a tissue is present. This tissue is called **meristematic tissue**. The parts of plants that give rise to new plants contain meristematic tissue.



Fig. 4.14 Corms in Gladiolus plant

Artificial methods of vegetative propagation

Vegetative reproduction offers several advantages. Therefore, several artificial methods have been developed for vegetative reproduction. These are commonly used to grow many plants from one plant. The process of growing new plants using artificial methods is known as **artificial propagation**. Some of these methods are discussed below.

GRAFTING

This method is commonly used in horticulture to develop new varieties of fruit plants. It consists of keeping a twig or bud of one plant (called the **scion**) over the cut stem of another plant (called the **stock**) and tying them up together. The stock should have an extensive root system under the soil. The tissues of the stock and scion join together to form one plant. The stock supplies the essential nutrients to the scion (Fig. 4.15).

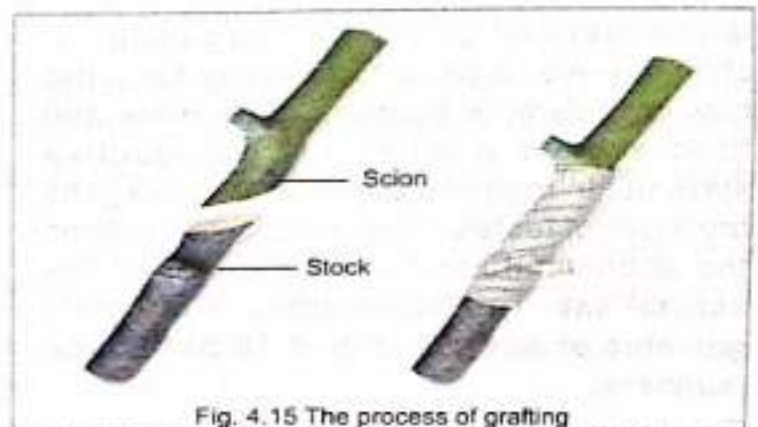


Fig. 4.15 The process of grafting

This method helps to develop new varieties by combining the features of two plants. For example, a high yielding variety may be grafted to a disease-resistant variety in an effort to develop a new variety with both characteristics. Many new varieties of mangoes have been developed by this method.

CUTTING

In this method, a healthy young branch of a plant having leaf buds is cut off and planted in moist soil. The cutting develops roots and grows into a new plant. This method is used to propagate plants like rose, bougainvillea and sugarcane. It allows many new plants to be produced from a single plant without waiting for flowers and seeds.



Fig. 4.16 Cutting

UNIT - 4

LAYERING

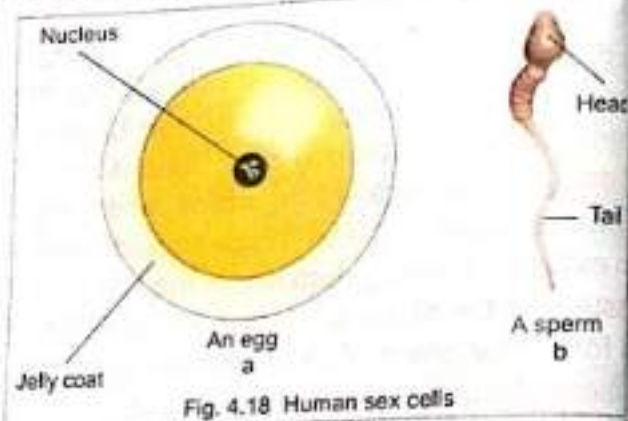
A young branch is bent towards the ground and covered by moist soil. After some time, roots develop from the covered part. This is called a **layer**. The branch can now be cut and made to grow into a new plant. This method is called layering and is commonly used by gardeners to develop plants such as jasmine (chameli), roses and bougainvillea.



(ii) Sexual reproduction

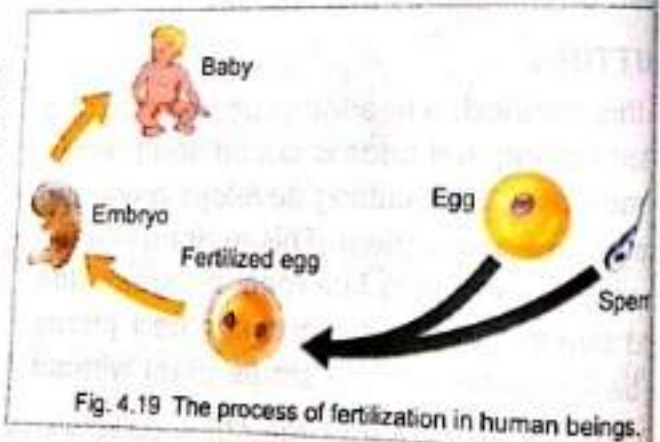
Most animals and plants reproduce by sexual reproduction. For sexual reproduction to occur, two parents, one male and the other female, are required. Each parent produces one reproductive cell or **gamete**. The male parent produces the **sperm** and the female parent produces the egg or **ovum**. The sperm and ovum fuse together and form the **zygote**. This process of fusion of the sperm and ovum is called **fertilization**. The zygote

is the first cell of the new organism. It changes over a period of time to form the new organism. In humans, both male and female have a different reproductive systems. In males, the reproductive organs are a pair of **testes**. They are located outside the abdominal cavity in a sac called the **scrotal sac**. The testes produce the male gametes or **sperms** (Fig. 4.18 b) in huge numbers.



The female reproductive organs are a pair of **ovaries**. The ovaries produce the **ovum** (Fig. 4.18 a). The ovum or egg is very small, about the size of this full stop. But the sperm are even smaller. The head of the sperm is 40 times smaller than the egg. The sperm also has a nucleus, but it is too small to see (Fig. 4.18 b).

FERTILIZATION: The sperms and ovum fuse together and fertilization takes place (Fig. 4.19). The fertilized egg divides over and over again, forming more and more cells. This mass of cells is called an **embryo**. The embryo grows and ultimately develops into a baby. The number of eggs produced at a time is different for different mammals. Humans,



elephants and cows usually produce one egg at a time. Cats, dogs and rabbits produce more than one egg at a time. Hence, more babies are born to them at the same time.

SEXUAL REPRODUCTION IN PLANTS

The parts of a flower

In flowering plants, flowers are the organs of sexual reproduction. There are four parts of a flower. These are the **sepals**, the **petals**, the **stamens**, and the **carpels**. They are arranged in rings, one inside the other.

The sepals protect the flower when it is in bud. They are usually green and leaf-like.

The petals are often brightly-colored and scented. There may be a nectary at the base of each petal which produces the sugary nectar.

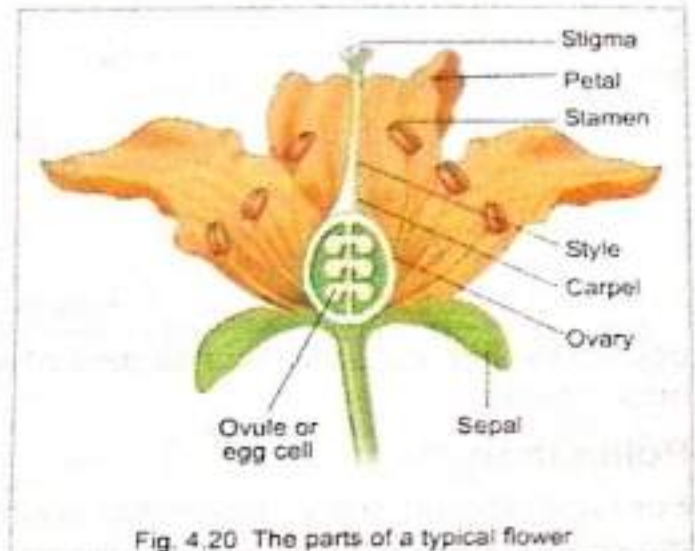


Fig. 4.20 The parts of a typical flower

The **stamens** are male reproductive organs. Each consists of an anther which contains pollen grains and a stalk called filament. Pollen grains contain the male sex cells.

The **carpels** are the female reproductive organs. Each carpel contains one or more ovaries in which the tiny ovules or egg-cells are found. An ovule contains the female sex cell and each ovule can grow into a seed. Above the ovary there is a narrow stalk called the style and this ends in the stigma. The stigma is often sticky, so that pollen grains can stick to it.

Some flowers contain both male and female reproductive organs, for example, apple, sweet pea, china rose, etc. They are known as **complete flowers** or **bisexual flowers**. Complete flowers have stamens, pistil or carpels petals and sepals.

Other flowers contain either male or female reproductive organs i.e. stamens or pistil, for example, corn and papaya. They are known as **incomplete flowers** or **unisexual flowers** (Fig. 4.21). The stamens have anthers which contain the male reproductive cells called pollen grains. These are surrounded by a tough protective coat which saves them from drying out. The female cells are the ovules present in the ovary in the lower part of the pistil.



Fig. 4.21 A typical unisexual flower.

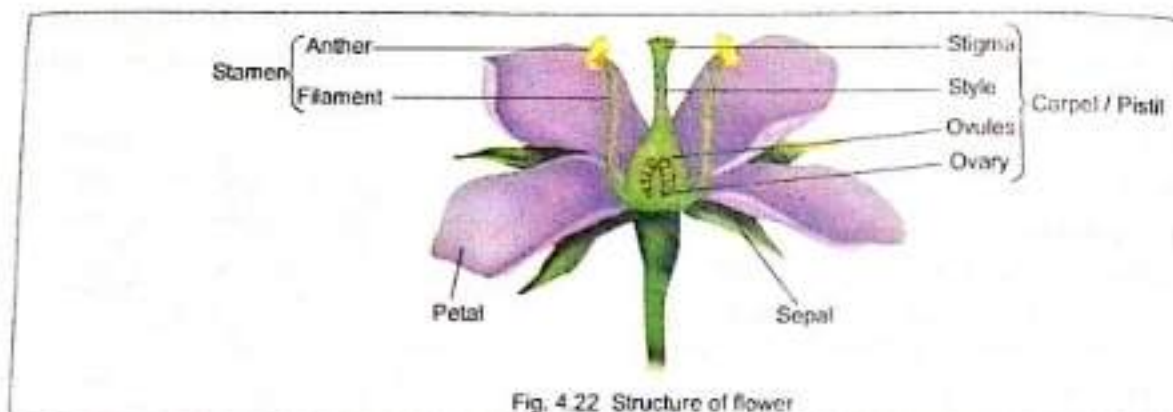


Fig. 4.22 Structure of flower

or carpels. Fig. 4.22 shows a section of a bisexual flower. The parts shown are found in most flowers.

Pollination

For fertilization to occur, the pollen grains must first be transferred from the stamens to the stigma of the pistil or carpels. This is called **pollination**. It occurs with the help of wind, water and insects.

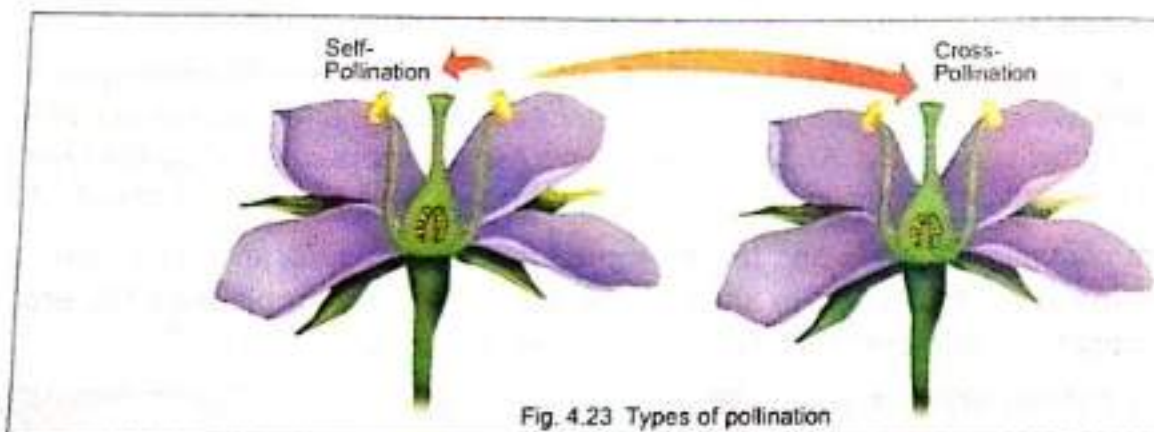


Fig. 4.23 Types of pollination

The pollen grains are either carried to the stigma of the same flower (**self-pollination**) or of a different flower of the same kind (**cross-pollination**) (Fig. 4.23). Cross pollination can take place through insects as well as wind.

CROSS POLLINATION BY INSECT:

Insects, birds and other animals help in cross-pollination of flowers. Insects are attracted by the colour and scent of petals. They collect nectar from flowers. Pollen grains from the anther stick to the insect's body. These grains get rubbed off when the insect visits other flowers for nectar.

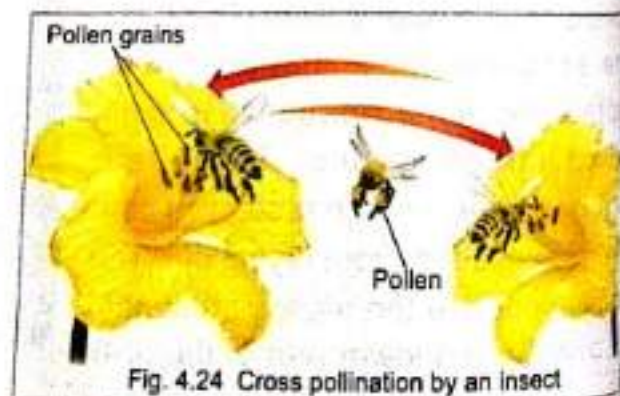


Fig. 4.24 Cross pollination by an insect

Good to know

Nectar is a sugar-rich liquid produced by plants in special glands called "nectaries". These nectaries are found either within or outside the flowers.

CROSS POLLINATION BY WIND : Wind can blow pollen grains from one flower to the stigmas of other flowers (Fig. 4.25). Such plants have flowers with small petals or with no petals at all. They also do not produce nectar.

In the absence of large petals, the anthers and pistils are exposed to the wind, making wind pollination easier. Corn, wheat and grasses depend on wind pollination.

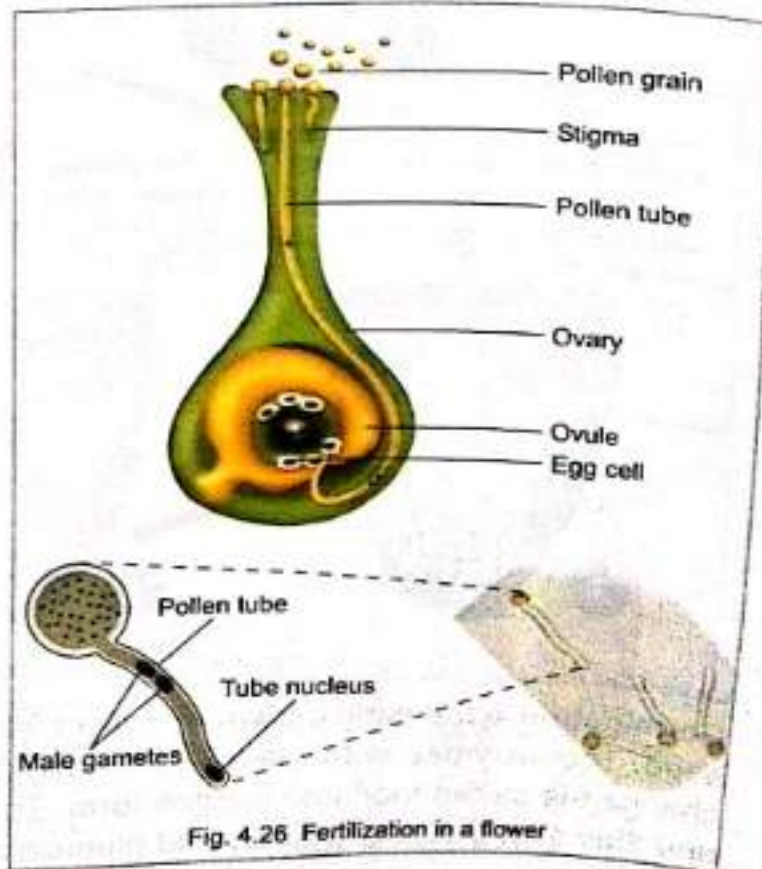
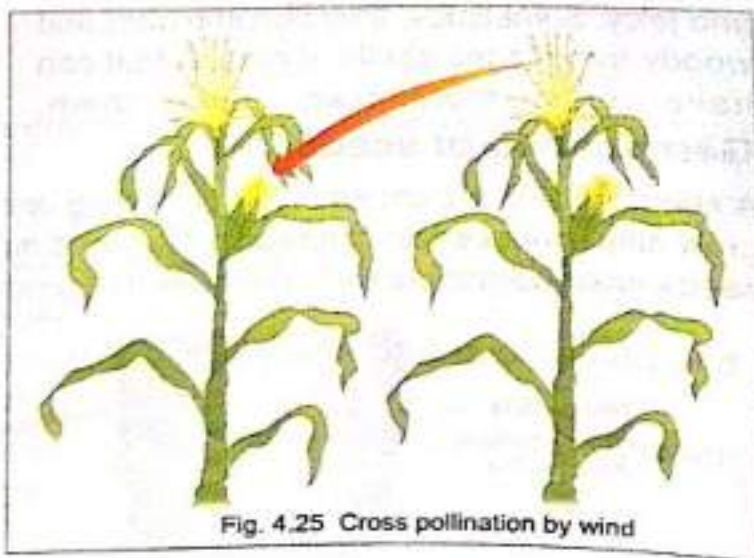
Fertilization in plants

The stigma of each flower secretes a liquid containing sugar. The pollen grains respond to this liquid and start growing. However, the pollen grain starts growing only, if the liquid is produced by a flower of its own species. They do not grow if they land on the stigma of a flower of a different species.

After pollination, a thin tube grows from the pollen grain called the **pollen tube** down through the pistil. It grows until it reaches the ovule and enters it. Two male nuclei move into the ovule and fuses with the eggs to form two zygotes (Fig. 4.26).

Seed formation

After the formation of the zygotes, the petals, sepals and stamens wither away and fall. Often the style and stigma also fall. Only the ovary remains. The ovules in the ovary contain food. The zygote uses this food and begins to grow by cell division and after sometime, becomes an embryo. Meanwhile, the walls of the ovules develop hard layers and change into seeds. Each seed consists of a young plant with stored food sealed within a hard layer.



UNIT - 4

Fruit formation

As the ovules change to seeds, the ovary begins to swell. In time, it becomes a fruit. So, a fruit is actually a developed ovary. Some fruits, such as mangoes and apples, are sweet and juicy. Sometimes, they become hard and woody forming the shells of nuts. A fruit can have one or more seeds inside them.

Germination of seeds

A seed contains a plant embryo in a resting or dormant stage: It is not growing. It can begin to grow only under certain conditions. The seed must get moisture and oxygen to germinate. Most seeds need warmth as well. When all the conditions are right, germination begins (Fig. 4.28).

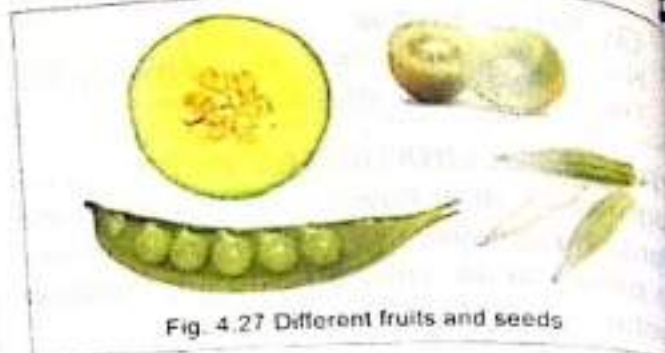


Fig. 4.27 Different fruits and seeds

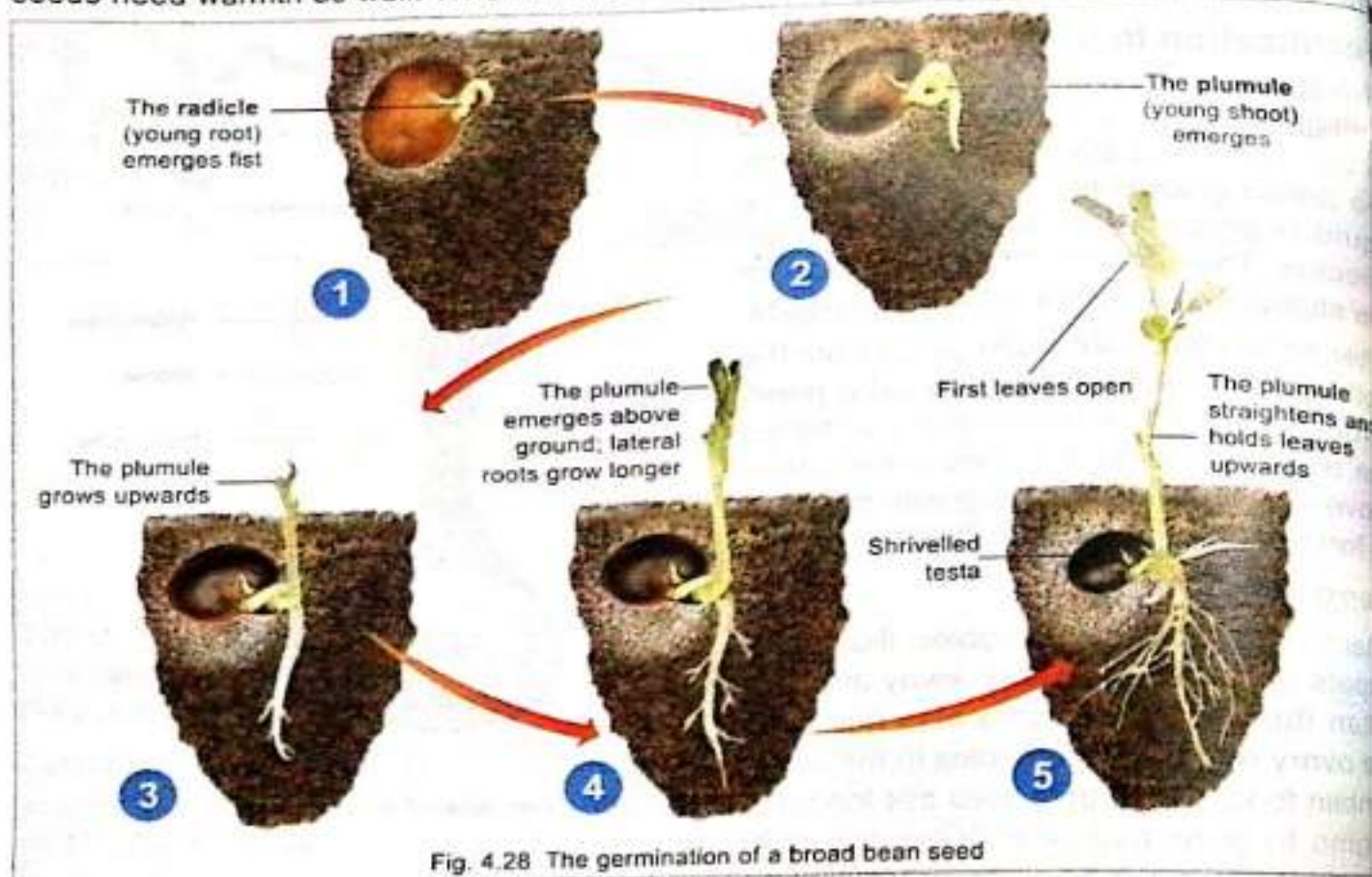


Fig. 4.28 The germination of a broad bean seed

Germination is the early growth of a plant from its seed. It begins with water intake by the seed. The enzymes in the seed start functioning when they get water. These enzymes change the stored food into soluble form. This then diffuses into the radicle and plumule and they start growing (radicle and plumule are the parts of plant embryo).

The **radicle** starts growing first and pushes down in the soil. It becomes the root. Then the **plumule** starts growing. It pushes up and grows into the shoot and leaves. The leaves start to make food by photosynthesis and thus the plant starts preparing its own food.

Good to know

In 1954, approximately 10,000 years old seeds were found frozen in Canada. In 1966 they all germinated. Amazing!

GROWTH

A baby grows into a man or a woman, a kitten grows into a cat and a seedling grows into a plant.

In multicellular organisms, growth occurs due to:

- an increase in the number of cells in each tissue by cell division,
- change in the size and shape of the cells, and
- deposition of materials such as fat. This leads to an increase in the size of tissues and organs of the body and, hence, of the whole organism.

The growth occurs in such a way that the structure of the body remains the same though the proportion of the different parts may change.

Growth in plants and animals

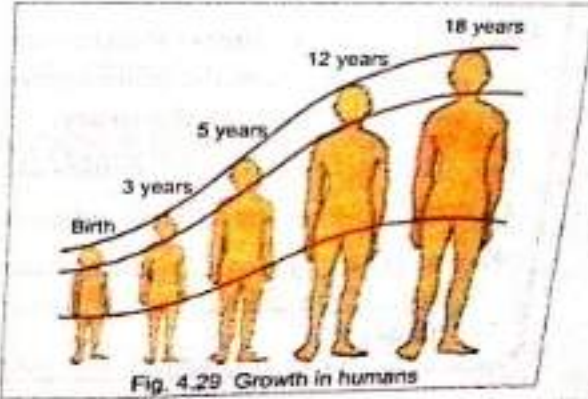
The growth in plants and animals differs in many ways (Table 4.1).

Table 4.1 Growth in plants and animals

Animals	Plants
Growth occurs in all parts of the body.	Growth occurs mainly at the tips of roots and stems. Only meristematic tissues present here have the ability to divide and produce new cells.
Growth stops after a certain age. In human beings, for example, it stops after 18-20 years of age.	Growth continues throughout the life of a plant.

Growth in humans

In humans, growth mainly occurs up to the age of about 20-22 years. The rate of growth varies at different ages. There is rapid growth for the first 3-5 years. Growth is less between 6-10 years and again increases during adolescence (11-18 years). Also different parts of the body increase in size at different rates. A child's head is bigger in proportion to the rest of the body. The growth of the head is slow while the arms and legs grow rapidly after adolescence.



Good to know

According to biologists, a normal human cell can divide up to 40-60 times and afterwards, it stops dividing. This limit is called Hayflick limit.

Amazing facts!

Tarantulas are large, hairy tropical spiders that look very dangerous but are quite timid in reality. They only bite when they are handled.

Let's work in team!

Divide students into groups. Each group is to collect different flowers from different places. Study the variations in the parts of these flowers. Classify these flowers into bisexual and unisexual flowers.

Teacher's corner

Take students to the science laboratory and show them the germination of seeds of millet grain, maize and pea by using cotton, water and test tubes/petri dishes.

**KEY POINTS**

Here is a list of key points to remember:

- 🔍 Reproduction is the process of producing new individuals of the same kind.
- 🔍 Asexual reproduction involves only one parent. Fission, budding, fragmentation, spore formation, vegetative reproduction and regeneration are examples of asexual reproduction.
- 🔍 Several artificial methods have been developed for vegetative reproduction.
- 🔍 Sexual reproduction involves two parents-one male which produces the sperm, and one female which produces the ovum. The process of fusion of the sperm and ovum to form a zygote is called fertilization.
- 🔍 In humans, the male reproductive organs are the testes which produce sperms. The female reproductive organs are the ovaries which produce the ovum.
- 🔍 In flowering plants, flowers are the reproductive organs. Fertilization occurs after pollination when the male reproductive cells in the pollen grain fuse with the egg cell within the ovule in the ovary.
- 🔍 After fertilization, the ovules change into seeds and the ovary into a fruit.
- 🔍 The seed begins to grow when it gets the right conditions.
- 🔍 In plants, growth continues throughout their life and is confined to certain growth regions. In animals, growth stops after a certain age and is uniform in all parts of the body.

KEY WORDS

Fission:	division into two or more parts.
Accumulate:	to gather, collect, assemble.
Corms:	round, underground storage organ in plants.
Essential:	extremely important.
Gamete:	a mature male or female cell.
Zygote:	a fertilized ovum.
Wither:	become dry and fall off.
Radicle:	part of plant embryo that develop into a root.
Adolescence:	a period of time during which a person develops from a child into an adult.
Plumule:	a part of plant embryo from which stem develops.
Offspring:	children.
Multiple fissions:	division into several parts.
Spirogyra:	a kind of algae.
Propagation:	the breeding of plants.
Stem tuber:	a swollen part of a tuber.
Horticulture:	the practice of cultivation of garden plants.
Germination:	growth of a plant from seed.
Senescence:	loss of cell's power to divide.

**TEST YOUR KNOWLEDGE****A. Answer these questions:**

1. Define reproduction. Why is it important?
2. List the different kinds of asexual reproduction, giving one example of each.

3. How does *Hydra* reproduce?
4. Discuss, giving examples, three different ways of vegetative propagation.
5. What are the advantages of vegetative propagation?
6. What is artificial propagation of plants? Name three methods of artificial propagation.
7. Explain the following:
 - a. Cutting
 - b. Layering
 - c. Grafting
8. What is regeneration? Give names of two animals in which it occurs.
9. How is sexual reproduction different from asexual reproduction?
10. Write morphological differences between an ovum and a sperm.
11. What is pollination? How does it lead to fertilization? Explain with the help of a diagram.
12. Do you think insect-pollinated flowers can also be pollinated by wind? Why?
13. Discuss how a zygote develops into an individual.
14. What is the difference between growth in plants and animals?

B. Fill in the following blanks:

1. The method of reproduction that involves only one parent is called
2. Mosses and ferns reproduce by formation.
3. *Spirogyra* reproduces by
4. The process of growing new plants using artificial methods is called
5. The fusion product of sperm and ovum is known as
6. Flowers in which both male and female organs are present are called
7. Fruit is a developed
8. Formation of an individual from two parents is called
9. Starfish can reproduce through
10. Bacteria and *Amoeba* reproduce asexually by
11. The process of ensures continuity of life on earth.

C. Decide whether the following statements are TRUE/FALSE:**TRUE****FALSE**

1. Improper working of the reproductive organs can lead to death.
2. Fission can be either binary or multiple.
3. Potato develops from seeds.
4. Flowers are the reproductive organs of plants.
5. Female reproductive organs are in the form of a pair of ovaries.
6. Complete flowers are bisexual.
7. A seed cannot start germinating in the absence of water.
8. Nectar is a sweet liquid usually present at the base of flowers.
9. The plumule starts growing first.
10. After fertilization, the ovule changes into seeds.

☐	☐
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D. Give one-word answers of the following questions.

1. Is binary fission sexual or asexual reproduction?
2. What is the process of fusion of sperm and ovum called?
3. Is the fertilization in frog external or internal?
4. In humans, which organ produces sperms?
5. What kind of flowers do you expect to be attractive? Insect-pollinated flowers or wind-pollinated flowers?

E. Choose the most appropriate answer for the following statements:

1. Which of the following methods of reproduction is sexual?
 - a. vegetative propagation
 - b. regeneration
 - c. binary fission
 - d. none of these
2. *Hydra* reproduces by
 - a. budding
 - b. spore formation
 - c. vegetative reproduction
 - d. sexual reproduction
3. Which method of reproduction is a zygote related to?
 - a. asexual reproduction
 - b. sexual reproduction
 - c. spore formation
 - d. vegetative propagation

4. Which of these is the male reproductive organ in humans?
 - a. sperm
 - b. ovum
 - c. testes testis
 - d. ovary
5. Which of these is the male reproductive organ in plants?
 - a. pistil
 - b. pollen grain
 - c. stamen
 - d. ovule
6. Which of these is true?
 - a. In plants, growth occurs up to a certain age only.
 - b. In animals, growth occurs throughout life.
 - c. In plants, growth occurs all over the body.
 - d. In animals, growth occurs all over the body.

Homework Assignment



Search and write about what is meant by cloning. Also search about first cloned animal (dolly). Bring the information to the class to share it with classmates.

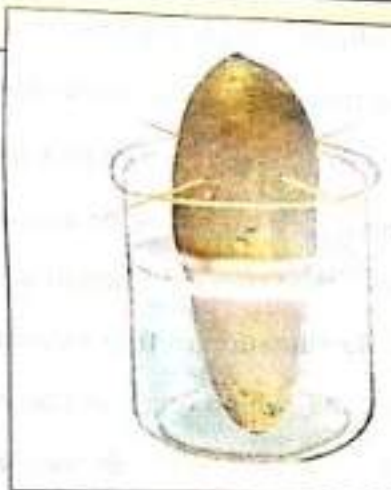
FUN WITH SCIENCE

Asexual reproduction in plants

You will need, a sweet potato, beaker, toothpicks, water

Procedure:

- ❑ Fill the beaker three-fourths with tap water. Insert four toothpicks around the centre of the sweet potato and place the sweet potato, with root side down, into the beaker, as shown in the figure.
- ❑ Put the beaker near a sunny window. Observe the beaker every day. Record the dates when the first new roots appear, and when the first new shoots appear.



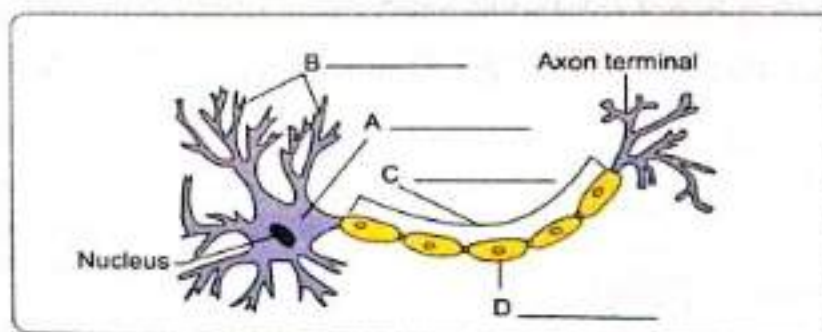
Formative Assessment - I (Based on Units 1 - 4)

Max. Marks: 25

Time: 30 minutes

A. Short - Answer Questions**(12 Marks)**

1. Explain why water and minerals are required by plants.
2. What is the difference in the arrangement of xylem and phloem in dicot stem and root?
3. Which cells are the longest cells in human body? Which body system do they belong to?
4. Why do unicellular and other lower organisms reproduce through asexual reproduction? Explain briefly.
5. Briefly explain the two necessary steps of respiration.
6. Explain why plants do not have specialized excretory system.

B. Label the lettered parts on the following diagram of a typical neuron.**(02 Marks)****C. Group Activity****(02 Marks)**

Visit the science laboratory and carry out an activity to observe budding in yeast cells.

D. Give one-word answers of the following questions:**(04 Marks)**

1. Is a conditioned response inherent or learnt?
2. What is the process of fusion of ovum and sperm called?
3. Which tissue is responsible for the transport of materials in human body?
4. Does digestion begin in mouth or stomach?
5. Name the plant movement which is performed as a response to the stimulus of light.

6. Name the respiration that takes place without oxygen.
7. Is binary fission sexual or asexual reproduction?
8. Which protein of red blood cells is responsible for the transport of oxygen?

E. Multiple Choice Questions

(05 Marks)

1. Steady movement of the body is controlled by this part of human nervous system:
 (a) Cerebrum (b) Cerebellum (c) Medulla oblongata (d) Spinal cord
2. This activity is related to increase in tidal volume in humans:
 (a) Sleeping (b) Studying (c) Standing (d) Walking
3. This metabolic waste is useful for us:
 (a) Urea (b) Sweat (c) Latex (d) Carbon dioxide
4. A cyst is associated with:
 (a) Unfavourable conditions (b) Multiple fissions
 (c) Amoeba (d) All of these
5. Which of the following is not related to bile?
 (a) Liver (b) Fat (c) Gall bladder (d) Protein

Continuity of Life and Variations

Learning Objectives

At the end of this unit, students should be able to:

- understand and define heredity
- understand and define nucleus and chromosome.
- understand and define gene and role of nucleus and chromosomes.
- understand that DNA is the hereditary material.
- understand and define variations in organisms.
- understand and define inheritance.
- understand and define inheritance of characters in organisms.
- explain how knowledge of inheritance is helpful in the production of new breeds of animals to increase meat, egg and milk products.
- understand how knowledge of inheritance has been used in the production of high yielding and disease-resistant varieties of plants in Pakistan.
- become aware of some important biotechnologies utilizing knowledge of inheritance.

HEREDITY

What do you understand by the term family?

How many family members live in your house?

You have parents, brothers and sisters and even grand parents. Family members often have similar characteristics. These characteristics have been passed from parents to children for many generations. What characteristics do members of your family have in common?

How are characteristics passed from one generation to the next?

Offsprings usually look like their parents. This is true for all living things. The offsprings of white cat are white kittens, and the black cats produce black kittens. **Traits** are characteristics, such as leaf shape, colour of flower, eye colour, etc. that are passed from parents to offspring. Offspring resemble their parents because they are derived from the product formed by the fusion of gametes. The gametes carry the characters of the parents. The zygote carries the characters of both parents. It develops and forms the young individual with a mixture of characters derived from both parents, hence the individual often resembles both the parents (Fig 5.1).

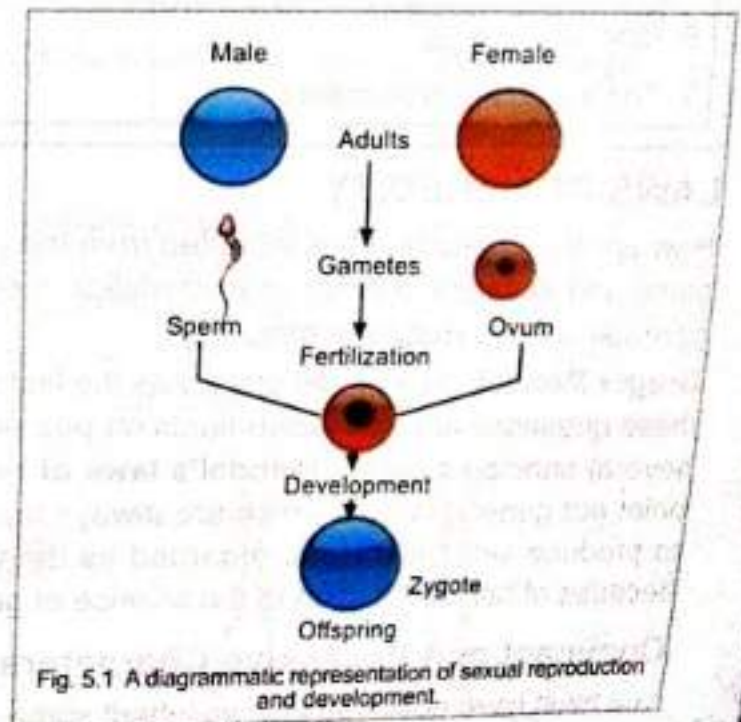


Fig. 5.1 A diagrammatic representation of sexual reproduction and development.

HEREDITY AND ORGANIC EVOLUTION

The transfer of characteristics from parents to their offspring is called heredity. The branch of biology which deals with the various laws of heredity is called **genetics**. Genetics seeks to provide the answers to two questions: *why do living things resemble each other?* *Why are they different?* All members of a given species, for example, man, are distinctly different from members of another species. All human beings are sufficiently similar as to leave no doubt that they are members of the same species. Besides, each individual can be distinguished from others of its own species. The difference between members of the same species is called variation.

ACTIVITY TIME! To observe resemblance and variation in a family.

Note the following characteristics in your grandparents, parents, your brothers and sisters, and yourself in the Table 5.1 given below:

Table 5.1

	Grand mother	Grand father	Father	Mother	Brother	Sister	Self
1. Ear (free/attached)							
2. Hair (straight/curly)							
3. Colour of hair							
4. Intelligence							
5. Height							
6. Complexion							
7. Tongue (roller/non-roller)							

LAWS OF HEREDITY

How are the characteristics inherited from the parents? How do we explain the presence of some and absence of other characteristics in offspring? How do we explain variation in parental characteristics in offspring?

Gregor Mendel, an Austrian priest was the first person who studied these questions and did experiments on **pea plants**. He proposed several principles called **Mendel's laws of heredity**. These laws point out genetic factors which are always true when cells divide to produce sex cells. He is regarded as the **father of genetics** because of his contribution to the science of genetics.



Fig. 5.2 Gregor Johann Mendel

Dominant and Recessive Characters

You must have observed that we inherit some characteristics from

the mother and some from the father. Those characteristics which are visible are generally **dominant characteristics** while those which are not visible but may be present in our cells are called **recessive characteristics**. They become visible in the absence of dominant characteristics.

Fig. 5.3 Gives some human characteristics which are inherited as dominant or recessive characteristics.

On the basis of the above chart try to find out the inheritance of characteristics, from your grandparents to your mother and father and from them to you and your brother or sister. Do you find some characters absent in your parents? Try to find answers to such questions with the help of your teacher. To understand heredity, we must have some basic knowledge about **nucleus**, **chromosomes**, **genes** and **DNA**.



Fig. 5.3 Different heritable traits of humans

NUCLEUS

It is the largest organelle of the cell. It is surrounded by a porous nuclear membrane. It controls all the activities of the cell. It is **circular** or **oval** in shape. Its fluid is called **nucleoplasm** which contains a **nucleolus**. It contains a network of fine **chromatin threads**. When the cell prepares to divide, the fine chromatin threads become visible as **chromosomes**.

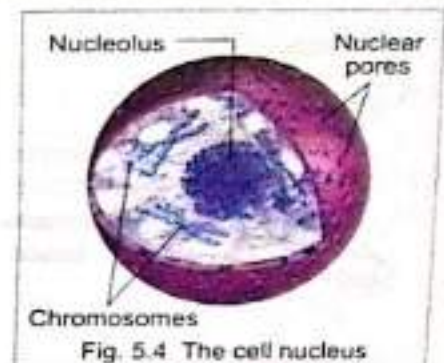


Fig. 5.4 The cell nucleus

CHROMOSOMES

A typical chromosome consists of two **chromatids** (Fig. 5.5a). The two chromatids are attached to the same **centromere**. The centromere divides the chromosomes into the equal-or unequal arms. According to the position of centromere, chromosomes may be **rod shaped**, **J-shaped** and **V shaped**. Chromosomes occur in pairs. Chromosomes having same shape and size are called **homologous chromosomes** (Fig. 5.5b).

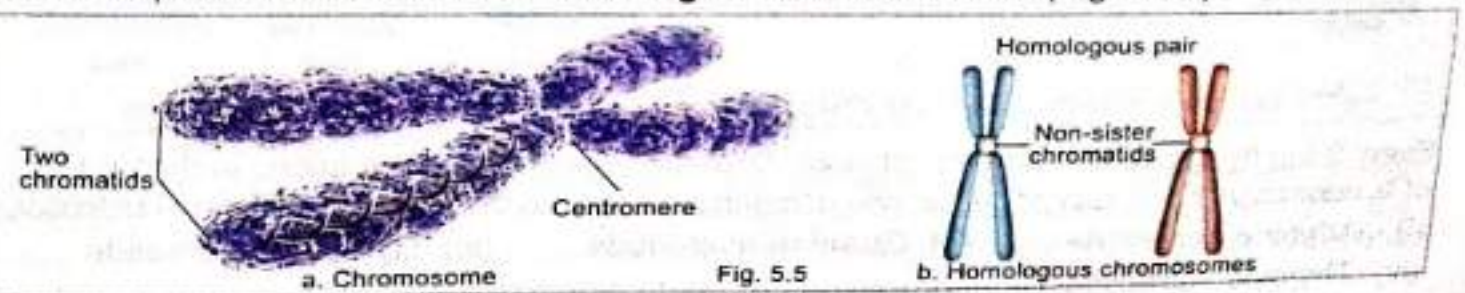


Fig. 5.5

GENES

Genes are responsible for the expression of all characteristics. The genes are located on the chromosome. The genes are arranged on the chromosome in a linear order. A gene is made up of a fragment of DNA, and responsible for the expression of a characteristic.

Characteristics are given to the offspring by parents. Suppose one character tall (T) is given by father so

another character tall (T) or short (t) will be given by mother. On homologous chromosomes one chromosome will have tall character at one place. Then the other member of the homologous will have either tall or short character at the same place. The number of chromosomes in every organism is fixed e.g. man has 46 chromosomes (23 pairs). In human one pair of chromosomes in male and female is different. It is called sex chromosome. In female it is called XX chromosomes and in male it is called XY chromosomes. The chromosomes are called **sex chromosomes** and the rest of the chromosomes are called **autosomes**.

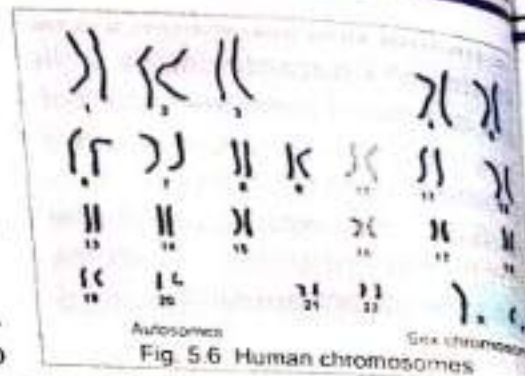


Fig. 5.6 Human chromosomes

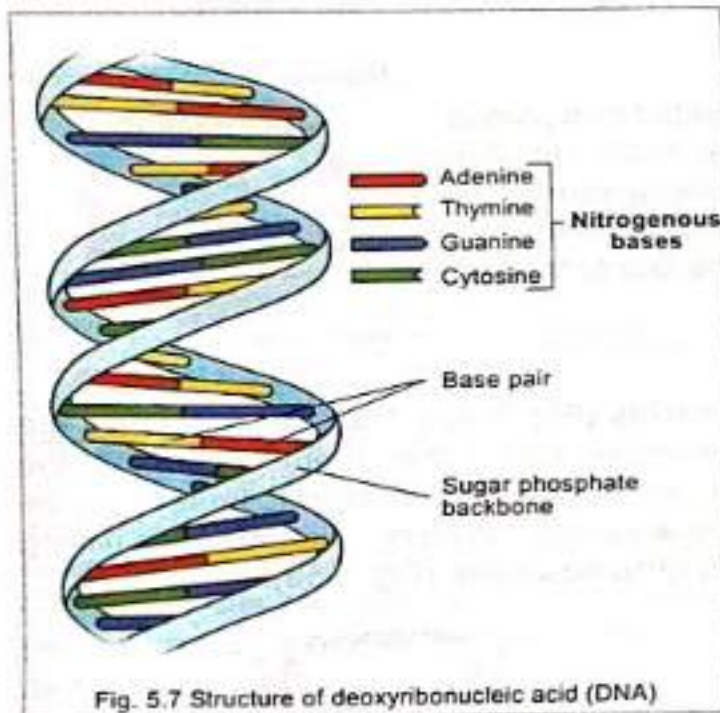


Fig. 5.7 Structure of deoxyribonucleic acid (DNA)

DNA (Deoxyribonucleic acid)

Chemically, a chromosome consists of proteins and a nucleic acid called deoxyribonucleic acid. A molecule of DNA consists of two strands linked with each other by bands like a ladder and twisted around each other. DNA is a very large molecule and consists of units called **nucleotides** (Fig. 5.7). A nucleotide consists of **phosphate, sugar and nitrogenous base** (Fig. 5.8). There are four types of bases: **Adenine, Thymine, Guanine and Cytosine**.

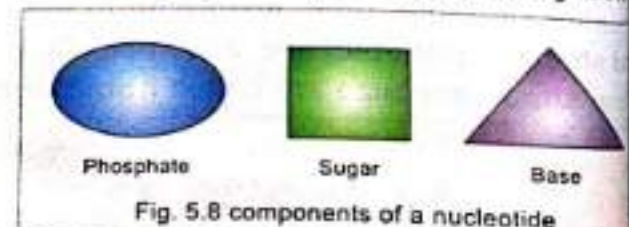


Fig. 5.8 components of a nucleotide

Every living thing has its own distinct DNA. DNA stores genetic information in the sequence of its nucleotides. Each nucleotide has one nitrogenous base, so there are four different nucleotides:

- (i) Adenine nucleotide (ii) Guanine nucleotide (iii) Cytosine nucleotide
- (iv) Thymine nucleotide

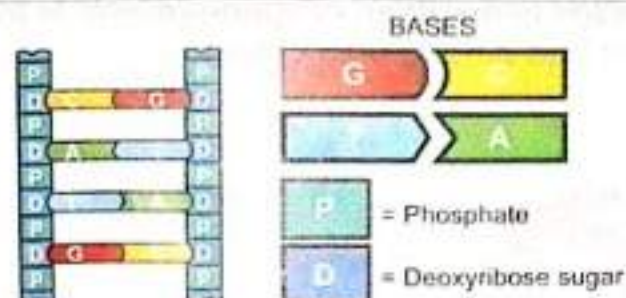


Fig. 5.9 A molecule of DNA



THINKING: How many words can you make with these alphabets?

A, B, E, R.

Some words are given below. Try to make more
BE, BEA, BEAR, BAR, BARE, EAR, ARE.

From the different arrangement of these four nucleotides, billions of characteristics and organisms are made. A characteristic or gene consists of a specific arrangement these nucleotides. DNA is transmitted from one generation to another generation through copying itself and this process is called **DNA replication**. DNA determines what type of characteristics would be developed in an organism.

Good to know

Any information about a character in living organisms is in a form of a particular base-pair sequence which is formed by a unique combination of four bases of DNA molecule. These four bases can make more than 3 million base-sequences.

WHAT IS INHERITANCE?

A family includes children, parents and grand parents.

The family members have similar or different characteristics such as eye colour, skin colour, hair colour, height and shape of nose and ears. These characteristics have been passed from parents to children for many generations. The process by which characteristics are transmitted from parents to their children is called **inheritance**. The characteristics are passed on from one generation to next by means of genes.

VARIATIONS

Variations are defined as the diversity among members of the same species. The characters which are different between two individuals of the same species are variations.

Dogs belong to one species yet they show striking variations (Fig 5.10).

Two butterflies or moths may appear to belong to two different species yet they may be of the same species. For a long time, man has wondered about variations produced in each generation. Why and how are variations produced?

The answers to these questions have been obtained during the last 100 years through the contribution of a number of workers in the field of evolution and heredity. Charles Darwin gave reasons for variations in nature on the basis of evolution. Gregor Mendel gave the causes of hereditary variations in nature and genes.

If all plants were identical, they would have perished together due to change in environmental conditions. This suggests that plants produce variations to develop tolerance to drought. Those which had more tolerance survived while those which had less tolerance died. Thus, variation is important for the survival in changing environmental conditions.

Variations occur in all plants and animals and in each generation, offspring resemble the parents but at the same time they differ from them and among themselves.



Fig. 5.10. Dogs belong to one species, *Canis familiaris*, yet they show variations. The picture above shows different varieties of dogs.

APPLICATION OF KNOWLEDGE OF INHERITANCE

Man has made good use of the knowledge of inheritance for his own benefit. Scientists identify good characteristics in plants and animals. Then they cross them to produce new breeds. These new breeds possess characteristics of their parents. This method is called selective breeding or artificial selection. You can see improvement of corn variety from selective breeding in Fig. 5.11.



Fig. 5.11 Improvement in corn variety

In Pakistan, scientists have made improvements in animals and plants. In poultry, several breeds have been developed which lay more eggs than common hens. Mixing characteristics like fast growth rate and good meat has developed broiler breed.



Fig. 5.12 Better variety of oranges



Fig. 5.13 Sheep that gives good wool and meat.

Mixing characteristics of different sheep has produced a breed of sheep that gives good wool and more meat.

We have achieved 6% increase in milk production by developing new breeds of dairy cattle.



Fig. 5.14 Cow with high milk yield

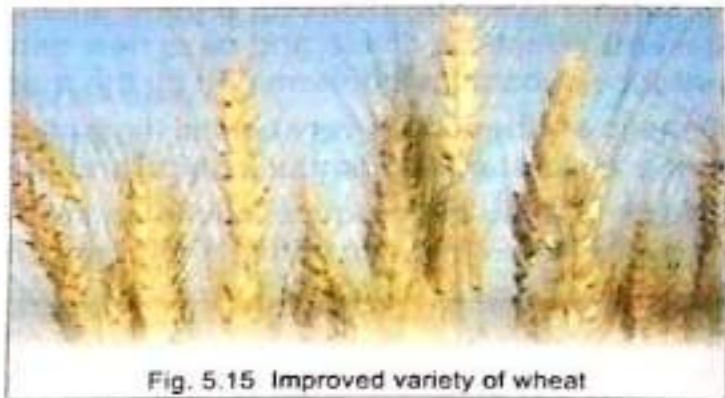


Fig. 5.15 Improved variety of wheat

New varieties of rice, wheat, cotton and sugar-cane have been produced which are disease-resistant, strong and give high yield.

Biotechnology

Biotechnology is a branch of biology that deals with the use of biological processes of animal cells and microorganisms for scientific and industrial processes. It is used to meet human needs. Today, biotechnology is being used in medicines to produce drugs and in agriculture to produce better varieties of crops and vegetables.



Fig. 5.16 Bread is prepared by using fermentation.

Fermentation is a biological process which is used to prepare different chemicals. As we know that respiration is the release of energy in living things. **Fermentation** is respiration with a waste product other than carbon dioxide and water. Fermentation is common in microorganisms. Their waste products are different chemical compounds which are used for purposes.

PREPARATION OF VINEGAR: A specific type of bacteria uses oxygen of air to carry out fermentation process in which energy is released and vinegar (acetic acid) is formed as a waste product.

PREPARATION OF YOGHURT: Bacteria ferment sugar of milk to produce lactic acid which produces yoghurt.

CHEESE PREPARATION: Different bacteria are added to milk that ferment sugar of milk to lactic acid and other chemicals that produce cheese.

Biotechnology and environment

Biotechnology is also being used to solve environmental problems. For example, domestic

wastes can be disposed off faster. Agricultural wastes such as husk of rice, which people used to burn, is now being used to produce substance that can be used in place of petrol.

Genetic engineering is changing of genes to produce new variety of plants and animals or substances. For example, a gene taken from a plant or an animal cell is inserted in bacteria. Bacteria divide and pass new gene to the next generations. These bacteria produce substances determined by the inserted gene.

Genetic engineering is very helpful for farmers to produce high yield crops and crop varieties that are resistant to harmful insects and diseases.

People who do not produce insulin on their own suffer from diabetes. Insulin, prepared by bacteria, helps diabetic patients to maintain level of sugar in blood.



Amazing facts!

Normally the human female produces one egg at a time so that one child is born at a time. When two babies are born at a time they are called twins. Some twins are of the same sex and are exactly alike. They are called **identical twins**. Others may be of the same or different sex and quite different from each other. They are called **non-identical or fraternal twins**. Identical twins grow from the same egg. Non-identical twins grow from two separate eggs when both ovaries produce an egg at the same time.



Let's work in team!

Divide students into 10 groups. One group is to make a list of varieties of animals that have been produced through selective breeding and genetic engineering; another is to make similar lists of plants. Discuss these lists with your teacher for better understanding.

Teacher's corner

Conduct a power point presentation in which explain the Watson and Crick model of DNA.



KEY POINTS

Here is a list of key points to remember:

- 🔍 Traits are the characteristics of an organism.
- 🔍 Heredity is the transfer of traits from one generation to the other.
- 🔍 The process by which characteristics are transmitted from one parent to offspring is

called inheritance.

- 🔑 The thread-like structures in the nucleus are the chromosomes.
- 🔑 Chromosomes are made up of protein and DNA.
- 🔑 Gene is the unit of inheritance.
- 🔑 Genes are fragment of DNA found on chromosomes.
- 🔑 A gene consists of nucleotides sequence of DNA.
- 🔑 Gregor Mendal proposed laws of heredity.
- 🔑 The knowledge of inheritance is used to produce new breeds of animals and plants.
- 🔑 Biotechnology is a branch of biology that deals with the use of animal cells and microorganisms in scientific and industrial processes.
- 🔑 Fermentation is the respiration of bacteria that produces different chemicals.
- 🔑 Biotechnology is also being used to solve environmental problems.
- 🔑 Genetic engineering is the insertion of new genes in organisms to produce new variety of plants and or substances.
- 🔑 The branch of biology which deals with the laws of heredity is called genetics.
- 🔑 Venations are defined as the diversity among members of the same species.

KEY WORDS

Traits:	features, quality.
Offspring:	children, babies.
Sufficient:	enough.
DNA:	deoxyribo nucleic acid.
Recessive:	gene that does not appear in the presence of dominant gene.
Fermentation:	chemical break down of substances by micro organisms involving effervescence.
Dominant:	a gene that suppresses the appearance of other gene.
Transmit:	to transfer.
Resemble:	to look similar.
Autosome:	chromosomes that do not determine sex.

**TEST YOUR KNOWLEDGE****A. Answer these questions:**

1. Define trait, gene, heredity, genetics, nucleotide, nucleus, chromosome and variation.
2. Name the components of DNA.
3. Who is regarded as father of genetics and why?
4. Describe the structure and function of nucleus.
5. Describe the structure of a chromosome.
6. Describe the following:
(i) Centromere (ii) Homologous chromosomes
7. How is a new variety of a plant produced through selective breeding?
8. Define biotechnology. Explain important uses of biotechnology.
9. Define genetic engineering. Explain its uses.

B. Fill in the following blanks:

1. The science of heredity is called.....
2. The thread-like structure found in nucleus is called
3. The unit of heredity is
4. Chromosomes occur in
5. Genes are present on
6. The same type of chromosomes are called.....chromosomes.
7. The activities of the cell are controlled by
8. Scientists identify good in plants and animals.
9. Yogurt is produced by process.
10. Biotechnology is also being used to solve problems.

11. Cheese is made by microorganism called
12. Chromosomes are made up of smaller units called
13. Fermentation is common in
14. People who do not produce insulins on their own suffer from

C. Decide whether the following statements are TRUE/FALSE:

	TRUE	FALSE
1. Offsprings usually look like their parents.	☐	☐
2. A typical chromosome consists of three chromatids.	☐	☐
3. Nucleus is the smallest organelle of the cell.	☐	☐
4. DNA is the abbreviation for deoxyribonucleic acid.	☐	☐
5. A chromosome consists of proteins and vitamins	☐	☐
6. Heredity is a passing of traits from parents to offspring.	☐	☐
7. Each living thing has same DNA	☐	☐
8. Genetics is the science of genes.	☐	☐
9. DNA stores genetic informations in the sequence of its nucleotides.	☐	☐
10. Charles Darwin is regarded as the father of genetics.	☐	☐

D. Choose the most appropriate answer for the following statemnts:

1. From parents, the eye colour is passed on to children through:
 a. blood b. gene c. cytoplasm d. structure of cells
2. Biotechnology makes use of:
 a. blood b. food c. bacteria d. chemicals
3. Vinegar is produced by:
 a. virus b. bacteria c. amoeba d. cell
4. Fermentation produces:
 a. carbon monoxide b. oxygen c. different products d. nitrogen

5. Yogurt is formed by the process of:

a. fermentation

b. evaporation

c. distillation

d. none of these

Homework Assignment



Study about the role of variation in evolution and write a note. Discuss various causes of variation with your teacher afterwards.

FUN WITH SCIENCE

Make a survey of students in your class. Group them according to their age. Examine the following characteristics:

(i) height, (ii) structure of earlobe – free or fused, (iii) eyebrow (free or united), (iv) nature of hair, and (v) ability to roll tongue.

Write against the name of each student (Table 5.2) about these characteristics.

Table 5.2

Name of student	Height	Ear lobe	Eye brows	Hair	Tongue	Any other

6

The Living Environment

Learning Objectives

At the end of this unit, students should be able to:

- understand and define environment.
- understand and define the term biosphere and its features.
- understand and define population and community.
- describe factors that cause increase or decrease in population.
- determine the effects of over population on the environment.
- discuss the role of man in causing disturbance in nature.
- understand and explain how excessive use of fuels and of other resources has led to resource depletion and environmental degradation.
- discuss how population growth, industrialization, urbanization and mechanized farming has contributed to environmental degradation.
- explain deforestation, green house effect, depletion of ozone layer and their consequences.
- participate in community's efforts in afforestation and controlling population.

POPULATION AND COMMUNITY

Living organisms do not live in isolation. All living things interact with one another and also interact with the nonliving surroundings in which they live.

The term environment is used to denote all living and non-living things. In other words, the living organisms and their surroundings constitute the environment.

Even on the earth, life is not found everywhere. The part of the earth where living things exist is called the **biosphere**.

The environment of a living organism in which it lives is called its **habitat**. The living organisms fulfil their requirements from their habitats.

Good to know

Living organisms that have maximum common features and can breed with each other to produce fertile offspring are called members of a species. For example cats, pigeons, rose plants etc, are different species.

The total number of living organisms of the same kind, living together at a place or habitat is called a **population**. Different populations or species living together and interacting with one another form a **community**.

ACTIVITY TIME! To observe different species.

Observe the figure 6.1. You can see different species. Identify the names of species and write their names.



Fig. 6.1 Different species

Population dynamics in an environment

The populations of living organisms in an area never remain constant in numbers. Increase or decrease is always occurring in it.

For example, you may have noticed that the number of mosquitoes and housefly in your area increases tremendously during early summer and the rainy season while they decrease in extreme hot and cold periods of the year. The population of a species of plants growing in a garden or field does not remain the same year after year. Similarly, the human population all over Pakistan is increasing especially in cities. High rate of increase



Fig. 6.2 Population increase in urban areas

in population can be seen in Karachi. There are so many causes of high rate of increase in population in Karachi. Similarly, there are many villages and areas where population is decreasing day by day. Now, we shall discuss the factors that are responsible for increase or decrease in populations.

FACTORS THAT INCREASE OR DECREASE POPULATION

The major factors that increase or decrease the population of an area are listed as under:

a. Migration from villages to cities

If people from outside come to settle in an area, the population increases in that area and this is called migration. While, if some individuals move out of an area, it results in decrease in population of that area and this is called exodus.

For example, due to greater job opportunities and better education and health facilities many people from villages migrate to cities. Because of this practice, population of cities increases and population of villages decreases. Increase in city population leads to many economical as well as social and environmental problems.

b. Difference between birth rate and death rate

If migration to or from an area is insignificant, the difference between birth rate (number of births per thousand population) and death rate (number of deaths per thousand) determines the growth rate.

$$\% \text{ of growth rate} = \left(\frac{\text{birth rate} - \text{death rate}}{1000} \right) \times 100$$

If death rate is lesser than birth rate, the population shows an increase, but if the death rate is higher than the birth rate, the population decreases. Growth rate tells us how fast a population is increasing.

ACTIVITY TIME! To calculate birth rate of Pakistan.

In Pakistan during 1998, the birth rate was 35 per thousand and death rate was 9 per thousand. calculate the growth rate in Pakistan in 1998.

Determination of the population growth rate is helpful to scientists, town planner and the people who plan for the future needs of the population.

c. Climatic conditions

Climatic conditions also play an important role in changing population balance. Natural climates like annually cold or hot weather, drought, excessive rains, floods and earthquakes have adverse effects on populations of an environment.

d. Diseases, famine and wars

Outbreak of epidemics such as plague, typhoid, cholera, malaria and small pox have had disastrous effects on human population. For example, spread of bubonic plague in the middle of the 14th century killed about 25% of population in Central Europe and Asia. Due to this disease, the population of England was reduced to half between 1379 and 1384.

Contrary to this situation, if better health, hygiene and sanitation facilities are available, the death rate (specially in children) sharply declines and there is an increase in population.

Famines and wars can also claim many lives in a short time period.



Fig. 6.3 Famine causes scarcity of food.

OVER-POPULATION

Every environment has the capacity to fulfil the housing, education, food and other requirements of life to a certain extent. If population exceeds the limit, the resources

become insufficient. As a result, balance between population and resources will be upset. Such a condition is called over population.

(i) Explosive growth rate of human population

Early man lived a nomadic life. He gathered naturally-occurring plant food i.e. fruits, leaves, roots, stems, seeds and hunted wild animals. At that time, population was low and it had very small impact on environment. Between 10,000 to 20,000 years ago, man began to grow crops and raise animals for food. With increased food supply and permanent settlement in cities, human population began to grow rapidly.

With the start of industrial era, human population began multiplying at an explosive rate. The world population that was about 500 million in 1650 surpassed 6 billion mark around the end of last millennium. The rapid rise in population is due to advances in medical sciences, agriculture and medicine. The demand on the earth for natural resources has increased with the rise in population. The increased demand for resources is a central cause of many environmental problems.

Good to know

The current population of the world is 7.3 billion. It is expected to reach 8.7 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100 according to the United Nations Department of Economic and Social Affairs.



Fig. 6.4 An early man

(ii) Effects of over-population on the environment

- ❑ More space is needed to accommodate large numbers of people.
- ❑ As land is cleared for housing and agriculture and is taken up by humans, there is less land available for other organisms.
- ❑ Population growth places a greater demand on resources such as minerals, fuels and food.
- ❑ Over-population causes destruction of habitats and loss of biodiversity.
- ❑ Pollution and human health problems are directly related to over-population.



Fig. 6.5 Housing destroys natural habitats.

ROLE OF MAN IN DISTURBING THE ENVIRONMENT

All types of environmental problems represent some forms of imbalance. This imbalance in nature is mainly caused by human activities. Many human activities such as excessive use of energy resources, over-exploitation of resources, discharge of industrial and urban refuse into air, water and land, and cutting of forests have posed serious threat to the environment. Pollution of air, water and land is a widespread problem today. Raw materials are running out. Actions of human being are affecting composition of atmosphere and global climate is changing.

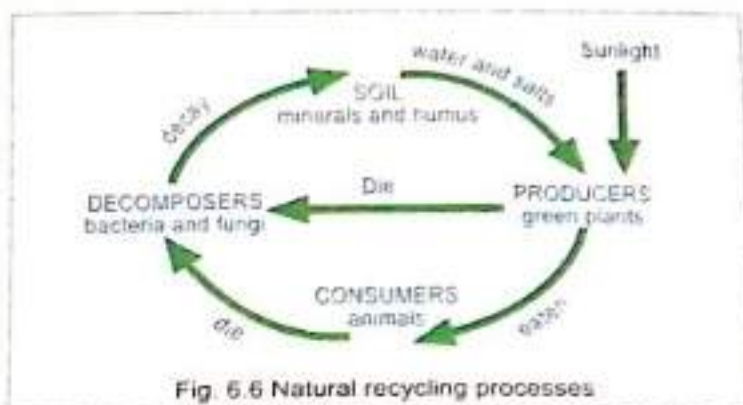


Fig. 6.6 Natural recycling processes

(i) Excessive use of energy resources

Energy is needed every time even when we are sleeping. Energy is needed in household, transport and production. However, a lot of energy which could do useful work is wasted by man. For instance, instead of using public transport, personal motorcycles and cars are used which consume a lot of fuel. Similarly, household appliances like iron, fan, bulb, tube light, air conditioner etc. are left running even when no one is using them. Such activities of humans are called misuse of energy and resources.



Fig. 6.7 Industrialization

(ii) Resource depletion

Natural resources are naturally-occurring materials that are used for human benefits. For example, oil, coal, minerals, trees and animals are natural resources. All the resources on earth are limited and many of them, such as minerals and fossil fuels, are **non-renewable**. A resource that cannot be regenerated quickly is called **non-renewable**.

resource. Our industrial society is highly dependent on the use of non-renewable resources. So, these resources may get depleted soon, if their unwise use is not stopped and they are not conserved. So, it is our responsibility to prevent energy and resources for our better future.

(iii) Industrialization

Increase in production is must for getting better facilities of life. For this purpose, man has popularized industry. This, rapid growth of industries is called industrialization. Energy is obtained from fossil fuels to run machines in the factories. In addition to fossil fuels, many chemicals are also used. Smoke, polluted water, wastes and other effluents from factories are major sources of environmental degradation.

(iv) Urbanization

It is a worldwide trend that due to the attraction of better facilities and living conditions more people are settling in different cities. Towns are changing into cities and cities into mega cities. During last fifty years, population of Karachi and Gujranwala has increased nine times, that of Quetta seven times and that of Peshawar six times. Highest rate of increase in population has been noted in Karachi.

Enlarging city population is the root cause of many environmental problems. Some of them are given below:

- ❑ Number of vehicles on roads is increasing day by day and the atmosphere is getting polluted by dust and the smoke emitted by them.
- ❑ Many people are forced to live in slums and this situation is causing many social problems.
- ❑ Useful agricultural land is used for residential purposes.
- ❑ Domestic and industrial wastes cause pollution of air, water bodies and land.
- ❑ Outbreak of epidemics and diseases is more likely in congested and over-crowded localities with poor civic and hygiene facilities.

(v) Mechanized farming

Mechanized farming makes use of machines, for example, tractors, harvesters and tube wells. Fertilizers and pesticides increase the production of crops and food but at the same time, they cause environmental problems for example land pollution.

(vi) Deforestation

Forests are playing a very important role in our daily life. They are our great wealth. For



Fig. 6.8 Urbanization



Fig. 6.9 Deforestation and its effects

are important to us in many ways. Some of them are given below:

- Forests bring healthy changes in climate of an area. They stop storms and bring rains. Rain is necessary for us because it refills water reservoirs.
- Forests are source of many useful materials such as timber, firewood, resins, gums and herbal products for medicines.
- They prevent soil erosion.
- They provide habitat to a wide variety of wild life.

Nowadays, forests are being removed to fulfil the demand for timber and, also to obtain land for housing, highways and agriculture. Consequently, the ecosystem is being destroyed day by day. Destruction of forests as a result of human activities is called **deforestation**. Deforestation has many adverse effects on environment. Some important effects are given below:

- As a result of deforestation, habitats of wildlife and plants are destroyed. Therefore, wildlife extinction risk is increased.
- Deforestation is one of the causes of change in weather and climate.
- Fertile soil is lost through soil erosion.

According to the department of Federal Bureau of Statistics, in Pakistan, forests occupied only 5% of our total area. It is too small. It is our need to increase the area of our forests.

(vii) Green house effect and global warming

Green house is a room made of glass or nylon nets. These houses are used to grow plants in them. They trap sun's beams and prevent their heat waves from going out. This results in an increase in temperature of the green house. This phenomenon is called **green house effect**.

Because of industrialization, the proportion of some gases in air, such as carbon dioxide, chlorofluorocarbons (CFCs) and methane (CH_4) has increased. Presence of these gases



(a) A green house



Fig. 6.10

(b) Green house effect

in air in higher proportion has produced the green house effect. Due to the green house effect, temperature of the earth is rising. This is called **global warming**.

(viii) Depletion of ozone layer

Ozone is a gas which is present in the form of an envelope around the earth in the upper atmosphere. This layer prevents ultra-violet radiations from the sun to reach earth.

Certain chemical substances, called chlorofluorocarbons, are released from refrigerators, air conditioners and cans of spray. These chemicals react with ozone and cause thinning and destruction of the ozone layer. Consequently ultra-violet rays can reach the earth. These rays may cause skin cancer, eye disease and etc. in human beings. These rays are also harmful for animals and plants.

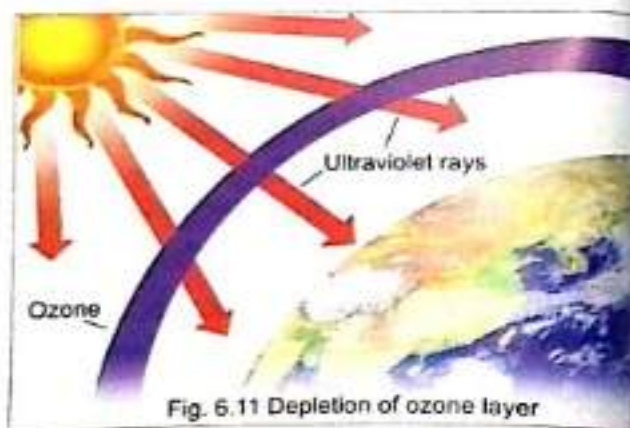


Fig. 6.11 Depletion of ozone layer

CAUSES AND PREVENTION OF ENVIRONMENTAL DEGRADATION

The unsustainable use of natural resources such as air, water and soil is environmental degradation which can lead to the destruction of ecosystem and natural habitat, extinction of species and pollution.

The basic cause of environmental degradation is man and his activities. In order to get better facilities of life, humans make excessive and unnecessary use of natural resources. We are polluting our atmosphere



Fig. 6.12 Aerosol spray release chlorofluorocarbons in air.

with smoke and poisonous gases (oxides of sulphur, carbon and nitrogen) emitted by vehicles.

Domestic wastes and industrial effluents are thrown into streams, rivers and other water bodies without being treated. This renders water of these water bodies unfit for human use. The life of aquatic animals and plants is also threatened. Fertilizers and agricultural chemicals are washed away into the water bodies. Forests are being cleared for obtaining timber, firewood and space. Thus, unwise and excessive utilization of resources is the major cause of environmental degradation.

We must think about environmental protection before the environment sustains irreparable damages. We must adopt measures which must conserve environment and its resources without hindering development and progress.

There are some important suggestions for the conservation of our environment and resources which are given below:

- ☐ Do not throw used and waste materials here and there. Dispose them off properly.
- ☐ Do not throw industrial and domestic refuse into air, land, and water without treatment. This may be done voluntarily by people and organization. Government must also make laws and enforce them effectively.
- ☐ Use green or pollutant-free fuels in transport.
- ☐ Minimize resource utilization. Improved technologies can reduce resource use and, thus, pollution.
- ☐ Conserve resources. Switch off lights, fans and air conditioners when no one is using them. Close water taps when not needed.
- ☐ Recycle plastic, glass, paper articles, etc.
- ☐ Prefer public transport over personal vehicles.
- ☐ Prevent the practice of cutting trees and plan to plant maximum trees whenever it is possible.



Amazing facts!

In clear water, the sunlight zone of marine water can be up to 100 metres deep. Millions of tiny plant-like creatures called phytoplankton live here. They are eaten by tiny animals called zooplanktons.

Let's work in team!



Study and make a list of those areas of the world which are going through with famine. Each student is to discuss his/her list with other students and teacher for better understanding.

Teacher's corner



Teacher/School authority should arrange a seminar for the students of class VIII on the following topics:

- | | | |
|---|---|---|
| ☐ Utilization of Resources | ☐ Depletion of ozone layer | ☐ Green House Effect |
| ☐ Global Warming | ☐ How can we form a healthy environment? | |

**KEY POINTS**

Here is a list of key points to remember:

- 🔍 All the members of species living in an area at a particular time form a population. Populations living and interacting together form a community.
- 🔍 Populations are always changing. Difference of growth and birth rates, climatic conditions, migration, diseases and famine are some major causes of changes in populations.
- 🔍 Over-population is basic and major cause of environmental problems. Resources also come under pressure due to over-population.
- 🔍 Human activities such as excessive use of resources, industrialization, urbanization, mechanized farming and deforestation led to environmental problems.
- 🔍 Global warming is taking place due to green house effect. Ozone depletion is also imposing harmful effects on the environment. Diseases like cancer are on the rise.
- 🔍 We must adopt such measures for conservation of nature which do not obstruct progress.

KEY WORDS

- | | |
|--------------------------|---|
| Exceeding: | very great. |
| Nomadic life: | a wanderer's life. |
| Explosive rate: | rapidly. |
| Famine: | extreme shortage of food. |
| Renewable energy: | source of energy which does not decrease when used. |
| Deforestation: | cutting down of huge amount of trees. |
| Extinction: | dying out. |

**TEST YOUR KNOWLEDGE**

A. Answer these questions:

1. What do you understand by population and community?
2. How increase in population leads to environmental problems?
3. What type of environmental problems arise from urbanization?

4. Describe benefits of forests and harmful effects of deforestation.

5. Write short notes on the following topics:

- Green House Effect
- Global Warming
- Ozone Depletion

B. Fill in the following blanks:

- All species living in an area form a
- Births per thousand in an area are called
- The resources which can not be regenerated within a short period are called
- Felling of trees and destruction of forests is called
- Ozone depletion may cause and

C. Decide whether the following statements are TRUE/FALSE:

	TRUE	FALSE
1. Living organisms of the same kind live separately.	☐	☐
2. Living things fulfil their requirements from their environment.	☐	☐
3. Environment of a living organism in which it lives is called its habitat.	☐	☐
4. The population of living organisms in an area remains constant.	☐	☐
5. No more space is needed to accommodate large numbers of people.	☐	☐
6. % of growth rate = $\left(\frac{\text{birth rate} - \text{death rate}}{1000} \right) \times 100$	☐	☐
7. If some individuals move out of an area, it results in decrease in population in that area.	☐	☐
8. Population of big cities is decreasing day by day.	☐	☐
9. Deforestation is one of the causes of changes in weather and climate.	☐	☐
10. According to the department of Federal Bureau of Statistics, our forests occupied 50% of our total area.	☐	☐

D. Encircle the most appropriate answer for the following statements:

1. Which gas of the atmosphere stops ultra-violet radiations from reaching the earth?
a. oxygen
b. nitrogen
c. ozone
d. carbon dioxide
2. Which of the following causes ozone depletion?
a. hydrogen
b. chlorofluorocarbons
c. ultra-violet radiation
d. oxygen
3. Ozone layer stops radiations from reaching the earth.
a. light
b. heat
c. infra-red
d. ultra-violet
4. One of the strong reasons of migration from villages to cities is:
a. lack of hospital
b. lack of houses
c. lack of water facility
d. lack of job opportunities
5. Living organisms of the same kind, living together at a place or habitat are grouped as:
a. community
b. population
c. species
d. family

Homework Assignment

Suppose a poster, placard or banner making competition is being held in your school or town on "Save Our Earth". Prepare posters, placards and banners for this competition.

FUN WITH SCIENCE

Initiate an "environment watch" wall magazine in your school and display related news and information.

Communication in Chemistry (Symbols, Formulae & Equations)

Learning Objectives

At the end of this unit, students should be able to:

- understand and define symbol and formula,
- learn and recognize the chemical symbols of the common elements,
- understand, define and explain the terms valency and radical,
- deduce the formulae of simple compounds from the charges on the ions or the valencies of the elements that combine to form them,
- name compounds whose formulae are given,
- understand, define and explain the terms — chemical equation, reactants, products and balanced chemical equation
- write chemical equations to show the chemical changes in simple reactions,
- construct balanced chemical equations,
- describe characteristics of chemical reactions,
- give examples and explain combination, decomposition, double decomposition and oxidation-reduction reactions.

CHEMICAL SYMBOLS

You are familiar with the use of shortened forms of names of people, names of countries etc. We refer to United Kingdom as U.K., United States of America as U.S.A., Kingdom of Saudi Arabia as K.S.A and so on. It is found to be more convenient to use the shortened forms instead of writing down long names. Similarly, in chemistry, symbols are used to represent names of elements. Thus, a **symbol is an abbreviated name of an element.**

Ancient alchemists used somewhat complicated symbols for known elements; these symbols are shown in Fig. 7.1

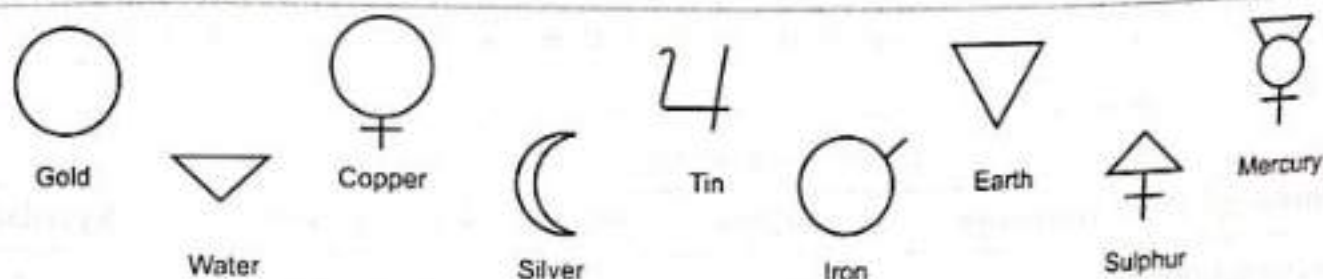


Fig. 7.1. Symbols used by alchemists

Later on, **John Dalton** proposed the use of symbols to represent the atoms of various elements. Some of the representations made by Dalton are given in Fig. 7.3.

As new elements were discovered, and new compounds were made from them, it became impossible to represent them as pictures. It was **J.J. Berzelius** who introduced the modern system of naming elements by their symbols in which they are represented by letters.



Fig. 7.2 J.J. Berzelius

	Hydrogen		Soda		Ammonia
	Nitrogen		Pot Ash		Olefiant
	Carbon		Oxygen		Carbonic Oxide
	Sulphur		Copper		Carbonic Acid
	Phosphorus		Lead		Sulphuric Acid
	Alumina		Water		

Fig. 7.3 John Dalton's symbols and formulae

MAKING SYMBOLS FOR ELEMENTS

We can use either the first letter or a combination of letters in making symbols of elements. For example, oxygen can be represented by the letter O. Similarly, for nitrogen, carbon, sulphur we can use the letters N, C and S respectively. However, in some elements the first letter is the same. For example, nitrogen and neon, carbon and calcium etc. have the same first letter. In such cases, we add the second letter to the first to avoid confusion. For instance, symbol for nitrogen is N whereas for neon, the symbol is Ne and for carbon and calcium is C and Ca respectively. Many elements starting with the same letter at a time, we use either the first letter or the first two letters of the Latin language. For example, iron in Latin language is known as ferrum, sodium is known as natrium and lead is known as plumbum. Therefore, the symbol for iron is Fe, for sodium is Na and for lead is Pb.

Good to know

Alchemy is an ancient version of chemistry in which methods to transform lower metals into gold and to find a universal elixir were studied. Muslim scientists were greatly involved in it.

Table 7.1 Symbols derived from English names of the elements

Name of the elements	symbol	Name of the elements	symbol
Hydrogen	H	Phosphorus	P
Helium	He	Sulphur	S
Lithium	Li	Argon	Ar
Carbon	C	Calcium	Ca
Nitrogen	N	Nickel	Ni

Table 7.1 Symbols derived from English names of the elements

Name of the elements	symbol	Name of the elements	symbol
Oxygen	O	Bromine	Br
Fluorine	F	Krypton	Kr
Neon ✓	Ne	Iodine	I
Aluminium	Al	✗ Barium	Ba
Silicon	Si		

Table 7.2 Symbols derived from Latin names of the elements

English name of the element	Latin name of the element	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
✗ Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
✓ Gold	Aurum	Au
Mercury	Hydrogyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn

CHEMICAL FORMULAE OF ELEMENTS

We have studied earlier that a molecule is the smallest particle of an element or a compound and it has independent existence. Generally, elements are represented by their symbols only. However, some elements which are in molecular form are represented by their formulae.

Just as a symbol represents one atom of an element, the chemical formula represents one molecule of an element or a compound. For example, one molecule of oxygen element contains two atoms of oxygen, therefore, the formula of oxygen is O_2 . Please note that $2O$ represents 2 separate atoms of oxygen while O_2 represents a molecule of oxygen. Similarly, the molecular formula of nitrogen is N_2 , of hydrogen is H_2 and of chlorine is Cl_2 .

The inert gases like helium, neon and argon are monoatomic, so their symbols and formulae are just the same. All the metals are represented by their symbols; they do not have any separate formulae.

The chemical formula of an element is the formula that shows the actual number of atoms in one molecule of the element.

The molecular formulae of some common elements are given in Table 7.3.

Table 7.3 Molecular formulae of some common elements

Element	Formula	Number of atoms per molecule
Hydrogen	H ₂	2
Helium	He	1
Oxygen	O ₂	2
Sulphur	S ₈	8
Phosphorus	P ₄	4
Nitrogen	N ₂	2
Bromine	Br ₂	2
Chlorine	Cl ₂	2

CHEMICAL FORMULAE OF COMPOUNDS

The molecule of a compound consists of the atoms of the constituting elements in a definite ratio. Thus, the composition of a compound is fixed. The atoms are present in a molecule of a compound only in whole numbers.

For example, water is a compound whose molecule contains two atoms of hydrogen and one atom of oxygen. So, the formula of water is H₂O. In the formula H₂O, the symbol H₂ indicates two atoms of hydrogen and O represents one atom of oxygen. The number before a formula shows the number of molecules. For example, 2H₂O means 2 molecules of water. Similarly, one molecule of hydrogen and one molecule of chlorine make two molecules of hydrochloric acid. A molecule of hydrogen chloride is represented by the formula HCl. The digit '2' shows two molecules of hydrogen chloride.



Thus, if we know the number of atoms of the elements constituting a molecule of a

compound, we can write its chemical or molecular formula. In Table 7.4 some examples are given.

Table 7.4. Formulae of some common compounds

Compound	Formula	Constituent elements	Atomicity
1. Carbon dioxide	CO_2	Carbon (C) Oxygen (O)	1 2
2. Sulphuric acid	H_2SO_4	Hydrogen (H) Sulphur (S) Oxygen (O)	2 1 4
3. Sugar	$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	Carbon (C) Hydrogen (H) Oxygen (O)	12 22 11
4. Potassium Permanganate	KMnO_4	Potassium (K) Manganese (Mn) Oxygen (O)	1 1 4
5. Ammonia	NH_3	Nitrogen (N) Hydrogen (H)	1 3
6. Nitric acid	HNO_3	Hydrogen (H) Nitrogen (N) Oxygen (O)	1 1 3
7. Phosphorus Pentoxide	P_2O_5	Phosphorus (P) Oxygen (O)	2 5
8. Mercuric Chloride	HgCl_2	Mercury (Hg) Chlorine (Cl)	1 2
9. Aluminium Bromide	AlBr_3	Aluminium (Al) Bromine (Br)	1 3
10. Borax	$\text{Na}_2\text{B}_4\text{O}_7$	Sodium (Na) Boron (B) Oxygen (O)	2 4 7

The definition of chemical formula or molecular formula of a compound is:

The molecular formula of a compound is the formula that shows the actual number of atoms of different elements, present in one molecule of a compound, in the form of their symbols.

RADICALS

A radical is a group of atoms or a molecule that has unpaired electrons in outer shell. They combine like atoms, have their own combining power and can be represented by their own formulae. Unlike atoms, however, radicals do not have independent existence.

That is, they exist only in combination with some elements or another radical. For example, carbonate radical is represented by CO_3^{-2} and it contains one atom of C and three atoms of O and two negative charges. It combines with calcium (Ca) to form a compound called calcium carbonate (CaCO_3).

List of Common Radicals

Acetate	$(\text{C}_2\text{H}_3\text{O}_2)^{-1}$	Ammonium	$(\text{NH}_4)^{+1}$
Carbonate	$(\text{CO}_3)^{-2}$	Chlorate	$(\text{ClO}_3)^{-1}$
Chromate	$(\text{Cr}_2\text{O}_7)^{-2}$	Hydroxide	$(\text{OH})^{-1}$
Nitrate	$(\text{NO}_3)^{-1}$	Peroxide	$(\text{O}_2)^{-2}$
Phosphate	$(\text{PO}_4)^{-3}$	Sulfate	$(\text{SO}_4)^{-2}$

VALENCY

The ability of an atom of an element to chemically unite with a definite number of atoms of other elements is known as valency. Thus, valency is a measure of the combining capacity of an element. The magnitude of valency is expressed by a whole number.

For example, in a molecule of water, two atoms of hydrogen combine with one atom of oxygen. Therefore, the oxygen atom will have a valency of 2.

Let us consider some other compounds of hydrogen, such as:

HCl (Hydrochloric acid)

H_2S (Hydrogen sulphide)

NH_3 (Ammonia)

CH_4 (Methane).

In these cases, the atoms of chlorine, sulphur, nitrogen and carbon combine with 1, 2, 3, and 4 atoms of hydrogen respectively, therefore, their valencies will be expressed as 1, 2, 3, and 4 respectively.

We have seen that oxygen has a valency of 2 in H_2O . In the same way, Mg has a valency of 2 in MgO and Hg has a valency of 2 in HgO .

Elements with valency one are known as **monovalents**. Examples of monovalent elements are sodium and potassium. Elements with valency 2 are known as **divalents**. Examples of divalent elements are magnesium and calcium. Similarly, elements having valency three are known as **trivalents**. Examples of trivalent elements are iron (Fe) and aluminium (Al). Carbon (C) and silicon (Si) are **tetravalent elements**.

Some elements such as helium, neon or krypton do not combine at all. Their valencies are 0. They are called zerovalent.

The name, formulae and valencies of some common elements and radicals are given in Table 7.5.

Variable valencies

There are some elements like Cu, Hg, Fe and Sn which combine with different number of atoms to form different compounds. For example, iron combines with chlorine to form two compounds, i.e. FeCl_2 and FeCl_3 . In FeCl_2 one atom of iron combines with two atoms of chlorine. Thus, the valency of iron is two. In FeCl_3 , iron combines with three atoms of chlorine and its valency is 3. Such elements which show different valencies are said to have **variable valencies**.

The names, symbols and valencies of some elements having variable valencies are given in table 7.6.

Good to know

Elements having variable valencies form different compounds with different valency. For example, iron with valency 2+ forms green ferrous chloride while with valency 3+, forms yellowish orange ferric chloride.

Table 7.5. Formulae and valencies of some common radicals

Name of radical	Formula of radical	Valency
Chloride	Cl^-	1
Bromide	Br^-	1
Iodide	I^-	1
Oxide	O^{2-}	2
Sulphide	S^{2-}	2
Nitride	N^{3-}	3
Hydroxide	OH^-	1
Nitrate	NO_3^-	1
Sulphite	SO_3^{2-}	2
Sulphate	SO_4^{2-}	2
Carbonate	CO_3^{2-}	2
Phosphite	PO_3^{3-}	3
Phosphate	PO_4^{3-}	3
Ammonium	NH_4^+	1



Fig. 7.4 Ferrous (green) and ferric (yellowish orange) chloride

Table 7.6. Variable valencies valencies of some elements

Element	Symbol	Valency
Iron	Fe	2 or 3
Tin	Sn	2 or 4
Sulphur	S	2, 4 or 6
Copper	Cu	1 or 2
Mercury	Hg	1 or 2

WRITING OF CHEMICAL FORMULA OF A COMPOUND

We can write the formula for any compound, if we know the valencies of element and radicals and their symbols. In writing the formula of a compound, we follow the following steps:

- ❑ Write the symbol of elements or radicals present in the compound side by side. For example, H O.
- ❑ Write the valency of each element or radical at the right top corner (superscript). For example, H^1O^2 .
- ❑ Now interchange the valencies and write at the right bottom of each element or radical as subscripts. For example: $\text{H}^1 \searrow \swarrow \text{O}^2$ i.e. H_2O .
- ❑ If the valency number is divisible by a common number, divide and write the formula after simplification as shown below:

Mg_2O_2 is simplified into MgO , C_2O_4 is simplified into CO_2 and Hg_2O_2 is simplified into HgO

- ❑ If a radical also forms a part of a compound and if two or more units of a radical are needed, the number is indicated by enclosing the radical in brackets and writing the number on their right outside the brackets. For example, the valency of Zn^{2+} is two and valency of NO_3^- is one. The formula of Zinc Nitrate is $\text{Zn}(\text{NO}_3)_2$.
- ❑ The metallic part of the compound is always written first, followed by the non-metallic part.

Let us apply the above-mentioned rules for writing the formulae of the following compounds:

Example 1

Write down the chemical formula of sodium sulphate. Follow the above mentioned rules:

1. Write the symbols of sodium and sulphate Na SO_4
2. Write their valencies as superscripts $\text{Na}^1 \text{SO}_4^2$
3. Interchange the valencies by criss-cross rule and write as subscripts.
 $\text{Na}_2 \text{SO}_4$
4. Combine them to form formula.

Thus, the chemical formula of sodium sulphate is Na_2SO_4 .

Example 2

Write down the chemical formula of calcium carbonate. Proceed as before and write the steps:

1. Write the symbol of calcium and carbonate Ca CO_3
2. Write their valencies as superscripts $\text{Ca}^{2+} \text{CO}_3^{2-}$
3. Interchange the valencies and write as subscripts $\text{Ca}_2(\text{CO}_3)_2$

4. Remove the common factor 2 CaCO_3

Hence, the formula of calcium carbonate is CaCO_3 .

After getting some practice, you should be able to work this out mentally and write the formulae of the compounds in one step.

For your convenience, by using the above mentioned rules, the formulae of some compounds have been derived in Table 7.7

Table 7.7 Derivation of chemical formulae of some compounds

Compound	Elements/radicals with valencies		Formula
1. Hydrogen chloride	H^1	Cl^1	HCl
2. Ammonia (nitrogen hydride)	N^3	H^1	NH_3
3. Ferrous sulphate	Fe^{2+}	SO_4^{2-}	FeSO_4
4. Calcium hydroxide	Ca^{2+}	OH^1	Ca(OH)_2
5. Aluminium oxide	Al^3	O^{2-}	Al_2O_3
6. Hydrogen sulphate (sulphuric acid)	H^1	SO_4^{2-}	H_2SO_4
7. Ammonium carbonate	NH_4^1	CO_3^{2-}	$(\text{NH}_4)_2\text{CO}_3$
8. Calcium bicarbonate	Ca^{2+}	HCO_3^1	$\text{Ca(HCO}_3)_2$
9. Sodium nitrate	Na^1	NO_3^1	NaNO_3
10. Copper (II) sulphate	Cu^{2+}	SO_4^{2-}	CuSO_4
11. Iron (III) phosphate	Fe^3	PO_4^3	FePO_4
12. Zinc chloride	Zn^{2+}	Cl^1	ZnCl_2

SIGNIFICANCE OF THE FORMULA OF A SUBSTANCE

The formula of a substance signifies the following:

- ☐ It represents the name of the substance.
- ☐ It represents one molecule of the substance.
- ☐ It gives the names of atoms of all the elements present in the molecule.
- ☐ It gives the number of atoms of each element present in one molecule.
- ☐ It represents a definite mass of the substance (equal to molecular mass expressed in grams).

CHEMICAL REACTIONS AND EQUATIONS

When iron (Fe) and sulphur (S) are heated, they combine to form a new substance called

iron sulphide, (FeS). Water on electrolysis liberates H_2 and O_2 . These are examples of chemical reactions and are represented by **chemical equations**. A chemical reaction is the process in which change in the nature and composition of substances takes place. The substances that take part in a chemical reaction are called reactants and the substances that are produced after chemical reaction are called products.

A chemical equation is a representation of a chemical change by means of symbols and formulae. We must know the names and formulae of reactants and products to write a chemical equation.

Method for writing a chemical reaction

Follow the following rules while writing a chemical equation:

- Write the formulae of the reactants on the left hand side in an equation.
- Write the formulae of the products on the right hand side in an equation.
- Put the sign of an arrow ($\longrightarrow$) in between reactants and products.
- If there are two or more reactants or products, then plus sign (+) is placed between them.
- The number of atoms of reactants and products are made equal.

The process of equalizing the atoms of each type on left hand side (reactants) and right hand side (products) of an equation is known as "**balancing the chemical equation**."

- Never change a formula of either the products or of the reactants in order to balance the equation.
- All the reactants and products in a chemical equation must be written in a molecular form. Atomic forms are unstable. For example, if O_2 is taking part in a chemical reaction, it should be written as O_2 and not $2O$.

Let us apply the above rules to write correct equations in the following examples

Example 1

Electrolysis of water liberates H_2 and O_2 .

1. Step I: Write the formula of reactant (water)
 H_2O
2. Step II: Put an arrow sign after writing the reactant.
 $H_2O \longrightarrow$
3. Step III: Write the formulae of products after the arrow sign and insert a plus sign.
 $H_2O \longrightarrow H_2 + O_2$
4. Step IV: Now balance the chemical equation.
 $2H_2O \longrightarrow 2H_2 + O_2$

Example 2

When magnesium burns in oxygen, a white powder of magnesium oxide is formed.

1. Step I: $\text{Mg} + \text{O}_2$
2. Step II: $\text{Mg} + \text{O}_2 \longrightarrow$
3. Step III: $\text{Mg} + \text{O}_2 \longrightarrow \text{MgO}$
(Unbalanced)
4. Step IV: $2\text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO}$
(Balanced)

Example 3

Sodium hydroxide reacts with sulphuric acid to give sodium sulphate and water.

1. Step I: $\text{NaOH} + \text{H}_2\text{SO}_4$
2. Step II: $\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow$
3. Step III: $\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
(Unbalanced)
4. Step IV: $2\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
(Balanced)

SIGNIFICANCE OF A CHEMICAL EQUATION

Chemical equations provide us with a lot of information about a chemical reaction at a glance. They indicate:

1. The reactants that take part in a reaction and the products that are produced.
2. The quantities of the reactants and the products by mass or volume.
3. The number of molecules of reactants and the number of molecules of the product.

CHARACTERISTICS OF CHEMICAL REACTIONS

When a chemical reaction takes place, it shows one or more of the following characteristics:

(i) Evolution of a gas (2)

A gas may be evolved during a chemical reaction. If one of the reactants is a liquid or in solution form, evolution of gas is marked by **effervescence (bubbling)** in the liquid. The gas can be identified by testing it. The evolution of a gas is shown by an arrow pointing upwards ($\uparrow$).

- When zinc reacts with dilute sulphuric acid, hydrogen gas is given off. There is effervescence in the acid. The gas can be tested by applying a burning matchstick to it. Hydrogen burns with a pop sound. (2)



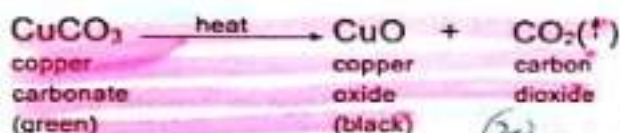
- When calcium carbonate is heated, carbon dioxide gas is given off. The gas can be tested by passing it through lime water. It turns lime water milky.



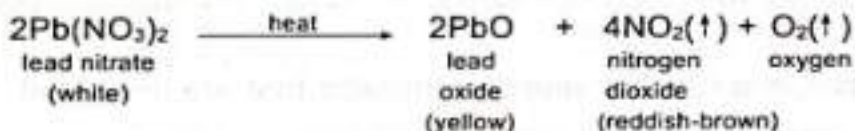
(ii) Change of colour

One of the products formed during a chemical reaction may have a different colour than the reactants. In such a case, change of colour accompanies the chemical reaction.

- When green-coloured copper carbonate is heated strongly, a black residue of copper oxide is left.



- When white crystals of lead nitrate are heated strongly, yellow coloured lead monoxide is formed. A reddish-brown gas, nitrogen dioxide is also given off.



(iii) Formation of precipitates

When two chemicals, normally in solution form, react, mostly an insoluble substance is formed that settles down in the form of precipitates. The colour of the precipitates depends on the colour of the insoluble compound. The formation of precipitates in a chemical reaction is shown by an arrow pointing downwards ($\downarrow$) by writing (ppt).

- When an aqueous solution of ferric chloride is mixed with ammonium hydroxide, brown precipitates of ferric hydroxide are formed.

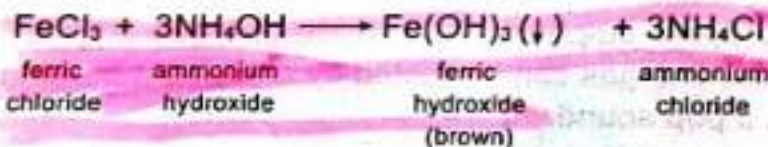


Fig. 7.5 Effervescence of CO_2 from CaCO_3 .

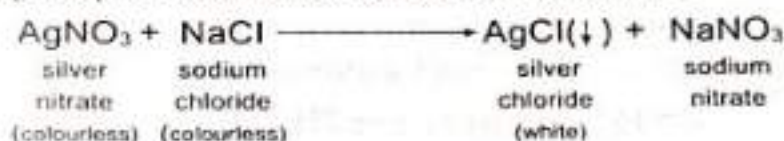


Fig. 7.6 Heating of copper carbonate to produce black copper oxide



Fig. 7.7 Precipitates of ferric hydroxide

- When a solution of silver nitrate (colourless) is mixed with a solution of sodium chloride (colourless), white precipitates of silver chloride are formed.



(iv) Energy changes

Almost all reactions are accompanied by energy changes. During the reaction, energy in the form of heat may be released or absorbed. Accordingly, there are following two types of chemical reactions:

(a) EXOTHERMIC REACTIONS

Exothermic reactions are the chemical changes during which heat is released. To show the release of energy, '+ heat' is written on the right hand side of the equation.

- All burning reactions are exothermic. When carbon burns in air, heat is released.



Fig. 7.8 Burning is an exothermic reaction.

- When water is added to quicklime (calcium oxide), heat is evolved and the water becomes very hot.



(b) ENDOTHERMIC REACTIONS

Endothermic reactions are the chemical changes in which heat is absorbed. To show the absorption of heat, either '+ heat' is written on the left hand side, or '- heat' is written on the right hand side of the equation.

- When carbon and sulphur are heated, they react to form carbon disulphide. Heat is absorbed in the reaction.



- When nitrogen and oxygen are heated to a high temperature, they react to form nitric oxide. Heat is absorbed in the reaction.



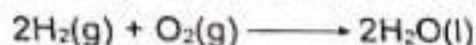
(v) Change of state

In some chemical reactions, there is a change in physical state. To show the change of state, **s** (for solid), **l** (for liquid), **g** (for gas) and **aq** (for aqueous) are written after their symbols or formulae.

- Electrolysis of water gives hydrogen and oxygen gases.



- When hydrogen burns in oxygen, liquid water is formed.



TYPES OF CHEMICAL REACTIONS

Certain patterns are observed in chemical reactions. Chemical reactions are, therefore, grouped according to these patterns. By using these patterns, we can predict the products formed in a large number of reactions. Some important types of chemical reactions are given below:

(i) Combination reaction

When a compound is formed from its elements, or from simpler substances, the reaction is called combination reaction. This type of reaction is also known as "synthesis".

- Nitrogen reacts with hydrogen to form ammonia.



- Magnesium reacts with oxygen on heating to form magnesium oxide.

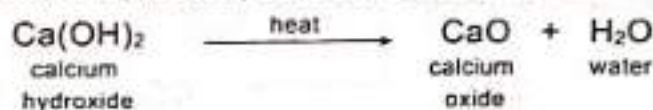


(ii) Decomposition reaction

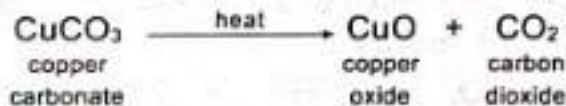
In decomposition reaction, a compound breaks up into two or more substances. Decomposition is normally caused by heating or by passing electricity.

For example,

- When calcium hydroxide is heated, calcium oxide and steam are produced.



- When copper carbonate is heated, it decomposes into copper oxide and carbon dioxide.



(iii) Displacement reaction

In this type of reaction, one element replaces another element in a compound. It is found that, in general, a more reactive element replaces a less reactive element from its compound.

For example,

- Iron is a more reactive element than copper. If a piece of iron is added to a solution of copper sulphate taken in a test tube, the blue colour of copper sulphate gradually fades away and a pale green solution of ferrous sulphate is formed and reddish-brown copper metal gets deposited on the iron piece.



Similar reactions are observed when magnesium or zinc reacts with copper sulphate.

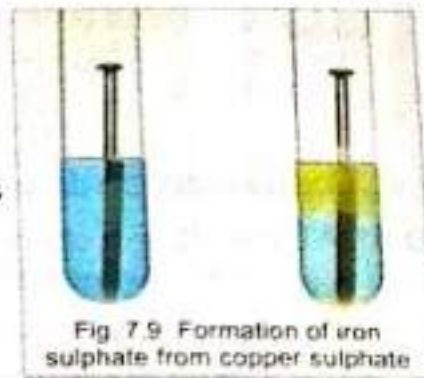
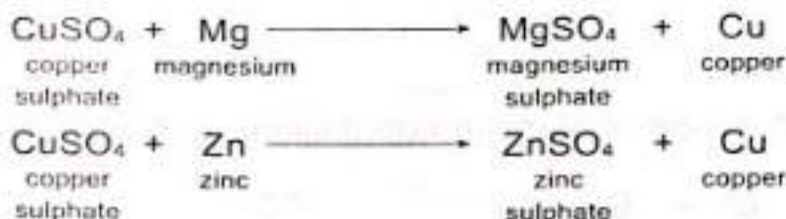


Fig. 7.9 Formation of iron sulphate from copper sulphate

(iv) Double displacement reaction

In a double displacement reaction, two compounds react by exchanging their radicals.



These reactions are of following two types:

(a) PRECIPITATION REACTIONS

In these reactions, two compounds react in their aqueous state to form an insoluble product which appears in the form of a precipitate. Here are some examples.

- Aqueous sodium chloride and silver nitrate react to form a white precipitate of silver chloride.



Fig. 7.10 Formation of silver chloride precipitates

- Aqueous sodium carbonate reacts with aqueous copper sulphate to form a precipitate of copper carbonate.



(b) NEUTRALISATION REACTIONS

In these reactions, an acid reacts with a base by exchanging their radicals to form salt and water.



- Sulphuric acid reacts with sodium hydroxide solution to form sodium sulphate (salt) and water.



- Hydrochloric acid reacts with potassium hydroxide to form potassium chloride (salt) and water.



(V) Oxidation and reduction reactions

OXIDATION: It is a chemical reaction which involves addition of oxygen or removal of hydrogen from a substance.

For example:

- When carbon reacts with oxygen to form carbon dioxide, it is said to be oxidized by gaining of oxygen.



- When hydrogen sulphide reacts with chlorine, the products are sulphur and hydrogen chloride.



In this reaction, hydrogen sulphide is oxidized to sulphur by losing hydrogen.

An **oxidizing agent** is a substance which oxidizes other substances by providing oxygen to them or by removing hydrogen from them. In the first reaction mentioned above, oxygen is the oxidizing agent, as it supplies oxygen to carbon. In the second reaction, chlorine is the oxidizing agent as it removes hydrogen from hydrogen sulphide.

REDUCTION: It is a chemical reaction which involves addition of hydrogen or removal of oxygen from a substance.

For example.

- When hydrogen is passed over heated black copper oxide, the latter changes to reddish-brown copper metal. Here copper oxide is reduced by losing oxygen.



- Chlorine reacts with hydrogen in the presence of diffused light to form hydrogen chloride. Here chlorine is reduced to hydrogen chloride by gaining hydrogen.



A **reducing agent** is a substance which can reduce other substances by removing oxygen from them.

from them or supplying hydrogen to them. In the reaction between CuO and H_2 , hydrogen is the reducing agent as it removes oxygen from copper oxide. In the reaction between Cl_2 and H_2 , hydrogen is the reducing agent as it supplies hydrogen to chlorine.

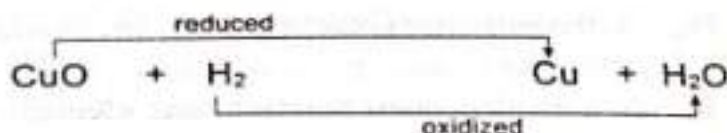
**Amazing facts!**

Two elements share the record for having the highest number of known isotopes. Both xenon and caesium have 36.

Good to know

Redox reaction: In chemical reactions, one substance is oxidized whereas the other substance is reduced. Thus, both oxidation and reduction take place at the same time. Hence, these reactions are called **redox reactions**.

For example, in the reaction between hydrogen and copper oxide, hydrogen reduces copper oxide by removing oxygen, and is itself oxidized to water by the addition of oxygen.

**Let's work in team!**

Write a note on the use of oxidation and reduction reactions in industries. Discuss your note with other students and your teachers to get better understanding.

Teacher's corner

Take students to science laboratory and show them practically some of the chemical reactions that have been discussed in this chapter.

**KEY POINTS**

Here is a list of key points to remember:

- 🔑 An element is represented by a symbol.
- 🔑 Symbols are the abbreviated name of elements.
- 🔑 The chemical formula of a compound represents the number of atoms of the constituent elements, their ratio and the mass of one molecule.
- 🔑 The valency of an element is a measure of its combining capacity with other elements.
- 🔑 A group of atom or a molecule with unpaired electrons is called a radical.
- 🔑 A chemical equation is a representation of a chemical change by means of symbols.

and formulae of reactants and products.

- 🔑 The process of equalizing the number of atoms on left hand side (reactants) and right hand side (products) of a chemical equation is known as balancing the chemical equation.
- 🔑 During a chemical reaction, substances undergo chemical transformation to form new substances.
- 🔑 Chemical reactions are characterized by one or more of the following characteristics: evolution of gas, change of colour, formation of precipitates, energy changes and change of state.
- 🔑 Heat is released during exothermic reactions. Heat is absorbed during endothermic reactions.
- 🔑 A combination reaction or synthesis is a reaction in which two or more substances combine to form a single substance.
- 🔑 A decomposition reaction is the one in which a compound breaks up into two or more substances.
- 🔑 In a displacement reaction, one element replaces another element in a compound.
- 🔑 In a double decomposition reaction, two compounds react with each other by exchanging their radicals.
- 🔑 Oxidation is a reaction that involves addition of oxygen or removal of hydrogen from a substance.
- 🔑 Reduction is a reaction that involves addition of hydrogen or removal of oxygen from a substance.
- 🔑 A reducing agent is a substance that reduces other substances.
- 🔑 An oxidizing agent is a substance that oxidizes other substances.

KEY WORDS

Abbreviated:	shortened form.
Complicated:	complex.
Latin:	the language of ancient Rome.
Precipitates:	insoluble particles that are formed during a chemical reaction.
Electrolysis:	breaking of a molecule by passing electricity through it.
Effervescence:	bubbles in liquid.
Residue:	something which is left behind in small amounts.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Define a symbol. Which elements are represented by the following symbols?
Na, K, Zn, S, Ca, Mg.
2. Write the symbols of barium, silver, gold, iron, mercury and neon.
3. Write Latin names of the following elements:
(a) sodium (b) potassium (c) iron (d) copper (e) silver (f) gold.
4. What does a chemical formula represent? Write the molecular formulae of calcium chloride, sodium oxide, zinc nitrate, calcium bicarbonate and aluminium chloride.
5. Name the following compounds:
(i) FeS (ii) HgO (iii) NH_4OH (iv) Al_2O_3 (v) ZnCO_3 (vi) $(\text{NH}_4)_2\text{SO}_4$
6. What is the difference between (i) 2O , O_2 and O^{2-} (ii) 2H , H_2 and H^+
7. What is a radical? Name the radicals, represented by the following formulae:
(a) CO_3^{2-} (b) SO_4^{2-} (c) OH^- (d) NO_3^- (e) NH_4^+
8. Write the symbols and valencies of the following radicals:
(a) oxide (b) nitrate
(c) sulphate (d) carbonate
(e) phosphate (f) ammonium
(g) hydroxide (h) sulphide.
9. Define the term valency. Define monovalent, divalent, trivalent and tetravalent elements and also give examples.
10. Name three elements which show variable valencies.
11. The formula of sulphuric acid is H_2SO_4 .
(a) Name the elements present in its molecule.
(b) State the number of different atoms present in a molecule of sulphuric acid.

(c) Does its molecule contain hydrogen in atomic form or molecular form?

12. Write down the formulae of the compound containing:

- (a) One atom of hydrogen, one atom of nitrogen and three atoms of oxygen.
- (b) One atom of hydrogen and one atom of chlorine.
- (c) Two atoms of sodium, one atom of carbon and three atoms of oxygen.
- (d) One atom of nitrogen and three atoms of hydrogen.

13. Give one example of each of a chemical reaction that shows the following characteristics

- a. evolution of a gas
- b. change of colour
- c. formation of precipitates
- d. change of state from liquid to gas
- e. change of state from gas to liquid

14. Balance the following equations:

- (a) $\text{Hg} + \text{O}_2 \longrightarrow \text{HgO}$
- (b) $\text{Na} + \text{Cl}_2 \longrightarrow \text{NaCl}$
- (c) $\text{Cu} + \text{O}_2 \longrightarrow \text{CuO}$
- (d) $\text{H}_2 + \text{Cl}_2 \longrightarrow \text{HCl}$
- (e) $\text{N}_2 + \text{H}_2 \longrightarrow \text{NH}_3$
- (f) $\text{Zn} + \text{O}_2 \longrightarrow \text{ZnO}$
- (g) $\text{P} + \text{Cl}_2 \longrightarrow \text{PCl}_3$
- (h) $\text{C} + \text{O}_2 \longrightarrow \text{CO}$
- (i) $\text{CaO} + \text{HNO}_3 \longrightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O}$
- (j) $\text{Na} + \text{O}_2 \longrightarrow \text{Na}_2\text{O}$

15. With the help of examples, distinguish between endothermic reactions and exothermic reactions.

16. What is a combination reaction? Explain with the help of two examples.

17. A decomposition reaction is the opposite of a combination reaction. Explain with the help of an example of each reaction.

18. Under which two conditions, decomposition reactions normally take place? Give one example of each.

19. What is a displacement reaction? What rule governs the replacement of an element in a compound by another element? Explain with an example.
20. Write these equations with the help of the symbols and formulae.
- | | | | |
|-----------------|------------|-------|-------------------------|
| (i) Zinc | + Oxygen | forms | Zinc oxide. |
| (ii) Phosphorus | + Chlorine | forms | Phosphorus trichloride. |
| (iii) Carbon | + Oxygen | forms | Carbon monoxide. |
| (iv) Hydrogen | + Chloride | forms | Hydrogen chloride. |
| (v) Nitrogen | + Hydrogen | forms | Ammonia. |
21. What is a double decomposition reaction? How many types of double decomposition reactions do you know? Give one example of each.
22. Explain the terms—oxidation and oxidizing agent and reduction and reducing agent.
23. When is a substance said to be reduced in a chemical reaction? What role does a reducing agent play in such a reaction?
24. Explain the meaning of a redox reaction with the help of an example.

B. Fill in the following blanks:

1. The concept of symbols of elements was first presented by
2. Symbols of some elements are derived from their names.
3. Neon and argon have valency.
4. The valency of aluminium is
5. Molecular formula of ammonia is
6. Double decomposition reactions are of type.
7. Heat is given out during an reaction.
8. If an equation has '+ heat' written on its right hand side it is an reaction.
9. An oxidizing agent provides or removes from a substance.
10. In a displacement reaction, ... element displaces elements.

C. Decide whether the following statements are TRUE/FALSE:

- | | TRUE | FALSE |
|---|--------------------------|--------------------------|
| 1. In Fe_2O_3 , the valency of oxygen is 2. | ☐ | ☐ |
| 2. Mg is the symbol of an element called manganese. | ☐ | ☐ |
| 3. The element calcium has a variable valency. | ☐ | ☐ |
| 4. Symbolic representation of compounds is its chemical formula. | ☐ | ☐ |
| 5. The symbol of oxygen is O_2 . | ☐ | ☐ |
| 6. The substances that take part in a chemical reaction are called reactants. | ☐ | ☐ |
| 7. The substances that are produced in a chemical reaction are called products. | ☐ | ☐ |
| 8. $\text{H}_2 + \text{O} \longrightarrow \text{H}_2\text{O}_2$ | ☐ | ☐ |
| 9. In some chemical reactions, there is a change in physical state. | ☐ | ☐ |
| 10. Reduction is a chemical reaction which involves addition of hydrogen or removal of oxygen from a substance. | ☐ | ☐ |

D. Give one-word answer of the following questions:

- Do symbols represent an atom or a molecule?
- If a certain compound has a formulae H_2X , What is the valency of X?
- What does the group of atoms behaving as one unit called?
- What represents a compound with symbols of its constituent elements?
- What do we call a group of elements having zero valency?

E. Choose the most appropriate answer for the following statements:

- MCQ's are missing an element with valency 4 is said to be:

a. monovalent	b. divalent	c. trivalent	d. tetravalent
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- The total number of atoms in $(\text{NH}_4)_2\text{SO}_4$ are:

a. 5	b. 10	c. 15	d. 20
------	-------	-------	-------
- An arrow pointing downwards in a chemical reaction shows:

a. evolution of gas	b. formation of precipitate
c. oxidation	d. displacement

7. A chemical reaction in which heat is given out is called:
- exothermic reaction
 - endothermic reaction
 - decomposition reaction
 - neutralization reaction
8. In a combination reaction how many products are formed?
- one only
 - two only
 - one or two only
 - number cannot be specified
9. What happens in a displacement reaction?
- A more reactive element replaces a less reactive element.
 - A less reactive element replaces a more reactive element.
 - An element replaces another element which is equally reactive.
 - Any element can replace any other element with no relation to reactivity.
10. A neutralization reaction is a:
- decomposition reaction
 - displacement reaction
 - combination reaction
 - double displacement reaction
11. An oxidation reaction involves:
- addition of oxygen only
 - addition of hydrogen only
 - addition of oxygen or removal of hydrogen
 - addition of hydrogen or removal of oxygen

Homework Assignment

Study about the use of exothermic reactions in everyday life and make a note on these uses.

FUN WITH SCIENCE

Identify the type of each of the following chemical reactions:



Learning Objectives

At the end of this unit, students should be able to:

- understand and define acid, base and salt.
- list and explain, with examples and equations, the various properties of acids, bases and salts.
- name and write the formulae of some acids, bases, alkalis and salts.
- give uses of some common acids, alkalis and salts.
- understand and define an indicator and name some common indicators and state what colour changes they show in the presence of acids and alkalis.
- understand and define neutralization reaction and give examples and equations of neutralization reactions.

Compounds are formed by the combination of various elements. More than three million compounds are already known to us. It is not easy to learn the composition and properties of each compound. However, all the compounds are mainly classified into three groups. These groups of compounds are known as ACIDS, BASES and SALTS.

INTRODUCTION TO ACIDS

The word "ACID" comes from the Latin word "ACIDUS", which means "SOUR". The term "ACID" was introduced in chemistry to name those compounds which have a sour taste. Fruits that taste sour contain acids. For example, lemon, orange and grapefruit contain weak acids. However, some acids are very strong and dangerous to handle. For example, sulphuric acid (H_2SO_4) is one of the strongest acids. Strong acids like sulphuric acid can cause serious skin burns.

Today, we encounter these acids directly or indirectly in all of our normal life activities. Nearly all fruits contain acids and so do many common foods. Apples contain **malic acid**, in lemons, oranges and grapes **citric acid** is found, goose berries have **tartaric acid**. The souring of milk produces **lactic acid**. These substances are the examples of **naturally-occurring acids or organic acids**. Chemists have prepared several important industrial acids synthetically. They are often manufactured from minerals and ore, therefore, known as **inorganic acids** or more commonly as **mineral acids**. The most important mineral acids are sulphuric acid, nitric acid and hydrochloric acid.



Fig. 8.1 Citrus fruits contain citric acid.

Good to know**Strength VS concentration**

The strength of an acid must not be confused with its concentration. Concentration depends on the amount of water presents. Strength refers to the number of hydrogen ions. It is possible to have a dilute solution of strong acid. For example, dilute nitric acid is dilute solution of a strong acid. It has a pH of about 2, but it is not very concentrated.

acid (H_2SO_4), nitric acid (HNO_3) and hydrochloric acid (HCl).

The acids present in food stuffs are **weak**. Mineral acids such as sulphuric, hydrochloric and nitric acid are very **strong**. These acids must not be tasted. They are extremely corrosive. They corrode skin, clothes, metals and most of the other substances. These concentrated acids must be handled with care.

Good to know

Soft drinks contain a weak inorganic or synthetic acid called carbonic acid. This acid gives sour taste to these cold drinks.

INDICATORS

Substances which change colour when treated with acidic or basic solutions are called indicators.

Litmus, phenolphthalein and methyl orange are examples of common indicators. All acids and bases affect one or the other indicator.

The colours of the three commonly used indicators in acidic and alkaline solutions are given in Table 8.1.

Table 8.1 Colour of common indicators in acidic and alkaline solutions

Indicators	Acidic Solution	Alkaline Solution
Litmus	Red	Blue
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink

General properties of Acids

Acids have following general properties:

1. Acids have a sour taste
2. All acids turn indicators such as blue litmus and methyl orange red, but phenolphthalein remains colourless in acids.

ACTIVITY TIME! To show that acids change colour of indicators.

Take a little dilute HCl or H_2SO_4 solution in three separate test tubes and number them as 1, 2, and 3 respectively. Add two drops of blue litmus, methyl orange and phenolphthalein in test tube no. 1, 2 and 3 respectively. What changes in colour do you observe? You will notice that blue litmus and methyl orange turn red whereas phenolphthalein remains colourless. What do you conclude from this activity?

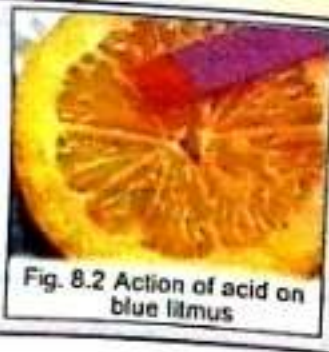
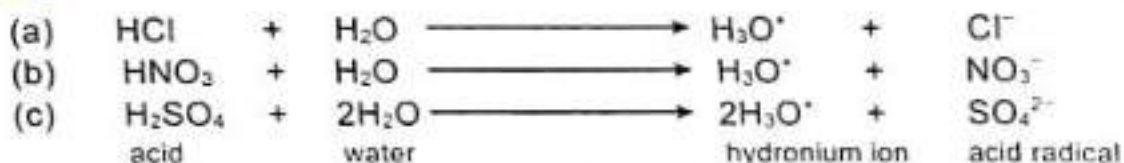


Fig. 8.2 Action of acid on blue litmus

3. All acids are compounds that contain hydrogen. Acids release hydrogen ion (H^+) in aqueous solutions as the only positive ion.
4. Acids produce hydronium ion (H_3O^+) in aqueous solutions.

Examples**Good to know**

All acids release hydrogen ions (H^+) in aqueous solution. These aqueous or hydrated hydrogen ions, H^+ (aq) combine with water molecules and are sometimes shown as H_3O^+ (aq) and called as hydroxonium or hydronium ions.

5. Acids react with active metals to form their salts and produce hydrogen gas. So, we can write:

**ACTIVITY TIME!** To observe reaction of acids with active metals.

Take about 5 ml of dilute hydrogen chloride (HCl), dilute sulphuric acid (H_2SO_4) and dilute acetic acid (CH_3COOH) in three different test tubes and add a piece of magnesium ribbon to each of the test tubes. What do you observe? There will be effervescence in each test tube. Test the gas by bringing a burning splinter near the mouth of each test tube. The gas burns with a pop sound which shows that the gas evolved is hydrogen. In this case magnesium replace hydrogen from these acids forming its salts as indicated in the given equations:



Similarly, some other metals like Na, K, Ca, Mg, Fe, Pb, Al etc. replace hydrogen from these acids.

However, metals like Cu, Hg, Ag, Au and Pt do not replace hydrogen from acids.



Fig. 8.3 HCl reacting with magnesium.

6. Acids decompose carbonates and bicarbonates into salts, water and carbon dioxide

So we can write:



Fig. 8.4 HCl decomposing calcium carbonate

ACTIVITY TIME! To observe action of HCl on calcium carbonate.

Take a small amount of calcium carbonate in a test tube and add about 2 ml of dilute HCl to it (Fig. 8.5). What do you observe? You will notice brisk effervescence. Pass the evolving gas into lime water, as shown in Fig. 8.5. What change in colour do you notice? Lime water will turn milky. The gas evolved is, therefore, carbon dioxide. The equation of the reaction of HCl on calcium carbonate is given below:

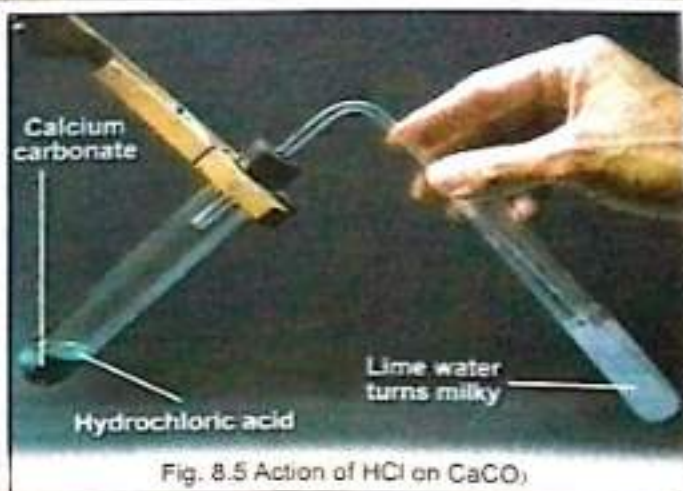
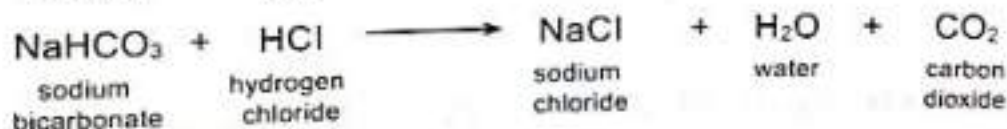
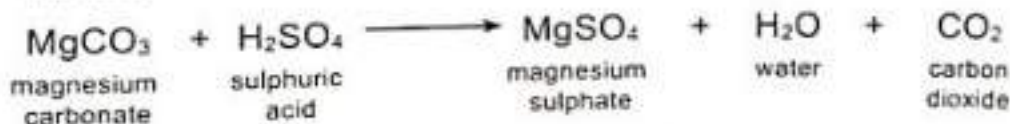
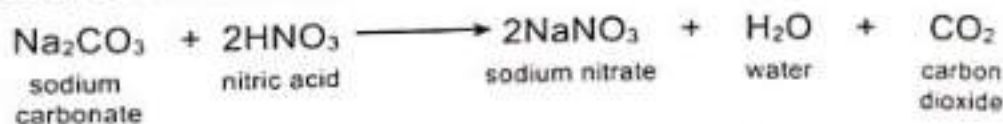
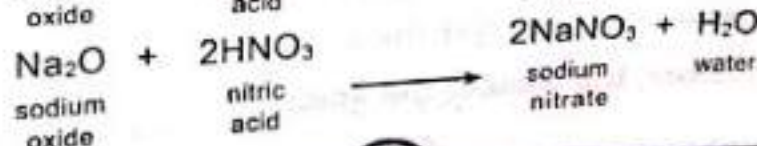
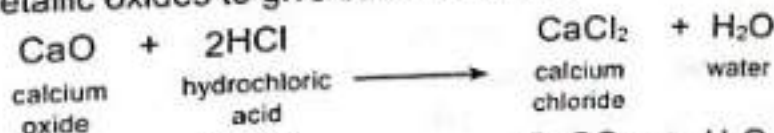


Fig. 8.5 Action of HCl on CaCO_3

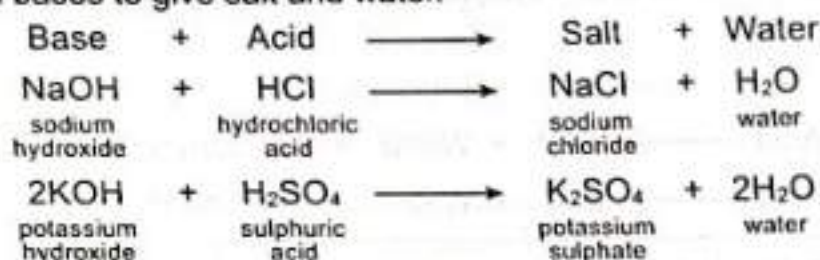
Some examples of such reactions are as follows:



7. Acids react with metallic oxides to give salt and water.



8. Acids react with bases to give salt and water.



Now, we can define acids in the following way:

An acid is a substance that contains one or more replaceable hydrogen atoms in its molecule and produces hydronium ions (H₃O⁺) in water.

Basicity of acids

The number of replaceable hydrogen atoms in a molecule of an acid is called the **basicity of the acid**. For example, HCl has one replaceable hydrogen, hence, its basicity is one and we call it **mono-basic**. Similarly, the basicity of H₂SO₄ is 2 and it is **di-basic**. The basicity of H₃PO₄ is 3 and it is a **tri-basic** acid. The basicity of some common acids is given in Table 8.2.

Table 8.2 Basicity of some common acids

Name of acid	Formula	Basicity	Nature
Hydrochloric acid	HCl	1	Monobasic
Nitric acid	HNO ₃	1	Monobasic
Acetic acid	CH ₃ COOH	1	Monobasic
Sulphuric acid	H ₂ SO ₄	2	Di-basic
Sulphurous acid	H ₂ SO ₃	2	Di-basic
Phosphoric acid	H ₃ PO ₄	3	Tribasic

pH value and strength of acids

Acids in the food we eat are weak. Other acids, such as the sulphuric acid used in science laboratories, can be very strong. The strength of an acid is measured by its **pH**. Every acid contains hydrogen ions (H⁺).

The stronger the acid, the more hydrogen ions there are in its solution.

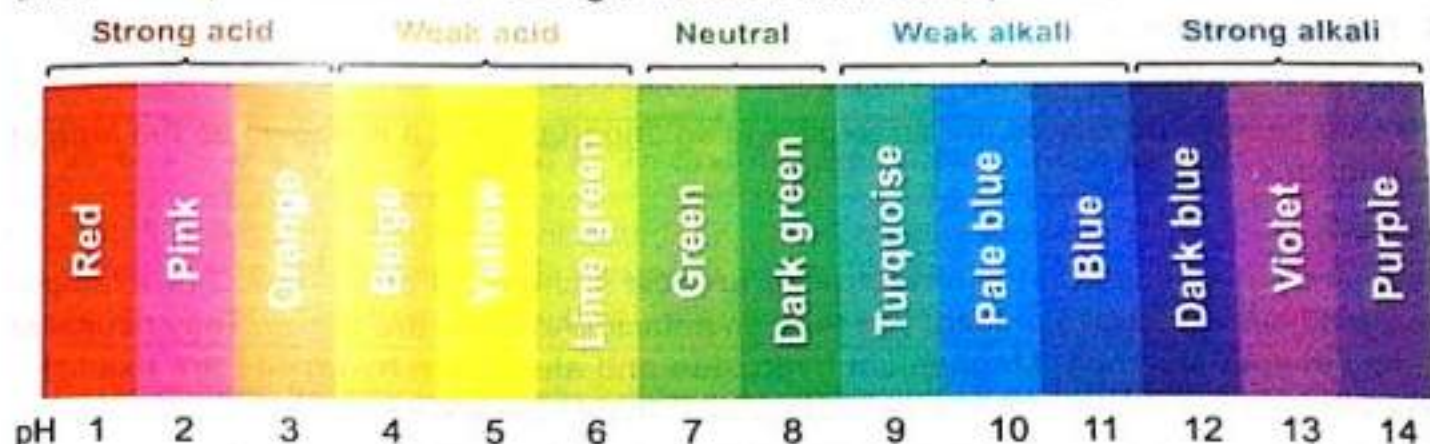
The lower the pH number, the stronger the acid.

The higher the pH number, the weaker the acid.

Good to know

Bee's sting contains an organic acid called 'formic acid'. That is why the effect of bee's sting can be neutralized to some extent by applying alkali or bicarbonate solution.

A substance with a pH of 7 is neutral. Pure water has a pH of 7. A chemical with a pH greater than 7 is called an alkali. The higher the pH, the more alkaline the chemical is. An alkali with a pH of 14 is much stronger than an alkali with a pH of 9.



Uses of Acids

Acids like HCl , H_2SO_4 and HNO_3 are used in chemical laboratories as reagents and in industries for various purposes. Some uses of common acids are listed as under:

1. HYDROCHLORIC ACID (HCl)

- ☐ It is used for the purification of common salt.
- ☐ It is used for cleaning of metals before soldering, tinning and galvanisation.
- ☐ It is used for making chlorides which are used for various purposes.
- ☐ It is used to make **aqua-regia** to dissolve noble metals such as gold and platinum.
- ☐ It is used for making glucose from starch.
- ☐ It is used as a reagent in laboratory and for making glue.
- ☐ It is also used for bleaching purposes in textile industries.

2. NITRIC ACID (HNO_3)

- ☐ It is used in the manufacture of fertilizers like ammonium nitrate.
- ☐ It is also used in the manufacture of explosives like trinitro-toluene (TNT), trinitro-glycerine, picric acid, gun powder, cotton, dynamite etc.
- ☐ It is used in the manufacture of some dyes, perfumes, medicines, plastics, artificial silk (rayon) and purification of gold and silver.
- ☐ It is used for etching designs or names upon metals like copper, brass or bronze.
- ☐ It is used in the extraction of metals.

3. SULPHURIC ACID (H_2SO_4)

- ☐ It is used as a dehydrating agent.
- ☐ It is used in the manufacture of fertilizers such as ammonium sulphate, ammonium phosphate and calcium super phosphate etc.

- ❑ It is used in the manufacture of celluloid, artificial silk, paints, plastics, drugs, detergents, etc.
- ❑ It is used in petroleum refining.
- ❑ It is used in textile, paper and leather industries, etc.
- ❑ It is also used in automobile batteries.
- ❑ It is used in the manufacture of synthetic fibre.

The uses of **sulphuric acid** are so large and so important that it is known as the **king of chemicals**.

BASES

Bases are substances that can neutralize an acid's chemical properties. For example, when you have an upset stomach, you take an antacid. Antacids are bases. They neutralize the acid in your stomach. Magnesium hydroxide and aluminium hydroxide are examples of weak bases and sodium hydroxide and calcium hydroxide are examples of strong bases.

When an acid reacts with a base, they neutralize each other and salt and water are formed. For example, when hydrochloric acid reacts with sodium hydroxide (or caustic soda), sodium chloride i.e. table salt and water are produced.

When reactive metals like sodium (Na), potassium (K) and calcium (Ca) react with water, hydrogen gas is liberated in each case and sodium hydroxide (NaOH), potassium hydroxide (KOH) and calcium hydroxide ($\text{Ca}(\text{OH})_2$) are formed respectively. These compounds are soluble in water. These compounds have the hydroxyl group (OH^-) in their molecules. The valency of the hydroxyl group (OH^-) is one. Therefore, any base can be written as $\text{M}(\text{OH})_n$ where 'M' stands for metal and 'n' for one or more hydroxyl groups according to the valency of the metal. For example, ferric hydroxide is written as $\text{Fe}(\text{OH})_3$ because the valency of ferric ion is 3.

Thus, a **base is a compound whose molecule is made up of one or more hydroxyl (OH^-) groups attached to a metallic atom.**

The number of replaceable hydroxyl ions in a molecule of a base is called its acidity.

Bases and Alkalis

Sodium hydroxide (NaOH), potassium hydroxide (KOH) and calcium hydroxide ($\text{Ca}(\text{OH})_2$) are soluble in water. **These soluble bases are called alkalis.**

Many bases do not dissolve in water. For example, cupric hydroxide ($\text{Cu}(\text{OH})_2$), ferric hydroxide ($\text{Fe}(\text{OH})_3$), aluminium hydroxide ($\text{Al}(\text{OH})_3$). All hydroxides are bases and only soluble bases are alkalis. Therefore, **all alkalis are bases but all bases are not alkalis.**

The relationship between bases and alkalis is given in Fig. 8.6.

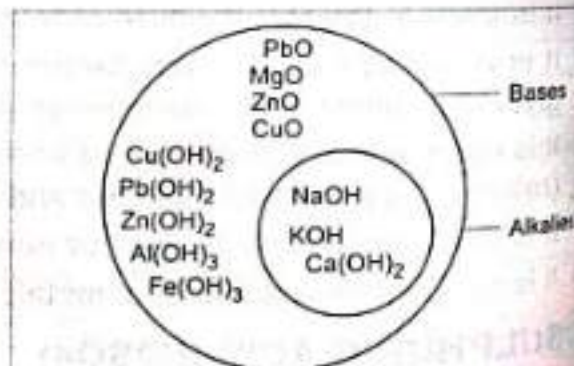


Fig. 8.6 Relationship between bases and alkalis

General Properties of Bases

Following are some general properties of bases:

1. Bases are bitter in taste.
2. All bases are slippery or soapy to touch.

ACTIVITY TIME! To find out that bases have soapy touch.

Rub a few drops of solution of sodium hydroxide between your fingers. What type of feeling do you experience? You get a soapy feeling.

What do you infer from this activity? Caution: Do not use concentrated solution.

3. Bases change the colour of some indicators for example, they turn methyl orange yellow, red litmus blue and phenolphthalein pink.

ACTIVITY TIME! To show that bases change colour of different indicators.

Take a little dilute solution of caustic soda or caustic potash (KOH) in three separate test tubes and number them 1, 2 and 3 respectively. Add two drops of methyl orange, red litmus and phenolphthalein in each test tube separately. What changes in colour do you observe?

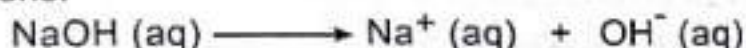
You will observe that methyl orange turns yellow, red litmus turns blue and phenolphthalein turns pink (See Table 8.1).

4. Bases are compounds that contain hydroxyl (OH^-) groups.

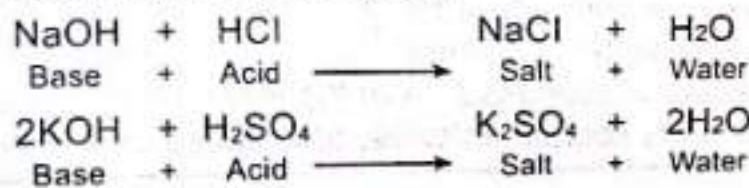
Most of the bases contain hydroxyl (OH^-) group. Molecular formulas of some commonly used bases are given below:

- NaOH (sodium hydroxide)
- $\text{Ca}(\text{OH})_2$ (calcium hydroxide)
- NH_4OH (ammonium hydroxide)
- KOH (potassium hydroxide)

5. All strong alkalis, when dissolved in water, readily dissociate to produce large number of hydroxide (OH^-) ions.



6. Bases react with acids to form salt and water.



Uses of Bases

Uses of some common bases are listed as under:

1. SODIUM HYDROXIDE (NaOH)

It is also known as caustic soda. It is largely used in:

- ☐ soap, textile and plastic industries.
- ☐ petroleum refining.
- ☐ making rayon.
- ☐ manufacture of medicines, paper, pulp.
- ☐ chemistry laboratory as a reagent.

2. CALCIUM HYDROXIDE [$\text{Ca}(\text{OH})_2$]

Solid calcium hydroxide is commonly called **slaked lime**. It is widely used in:

- ☐ the preparation of mortar, plasters and mixture of white wash.
- ☐ manufacturing of bleaching powder.
- ☐ making lime sulphur sprays to be used as fungicides.
- ☐ dressing material for acid burns.
- ☐ an antidote for acid poisoning.
- ☐ It is also used as a water softener and for neutralizing acidity of the soil.

3. AMMONIUM HYDROXIDE (NH_4OH)

It is used:

- ☐ As a reagent in chemistry laboratory.
- ☐ To remove grease from window panes.
- ☐ To remove ink spots from clothes.

NEUTRALIZATION REACTION

You have learnt that acids and alkalis have chemically different properties. What will happen when they are mixed? Let us do this activity.

ACTIVITY TIME! To neutralize an acid with a base.

Take 5 ml of dilute sodium hydroxide solution in a flask. Add two drops of phenolphthalein and shake the flask gently. The phenolphthalein (indicator) turns pink.

Now add a little dilute hydrochloric acid at a time by means of a burette or a dropper into the sodium hydroxide solution, shaking the flask constantly. Continue adding the acid until the solution in the flask becomes colourless. Note the volume of acid used. Heat the test tube over a flame to evaporate the liquid. The residue left is sodium chloride, also called common salt.

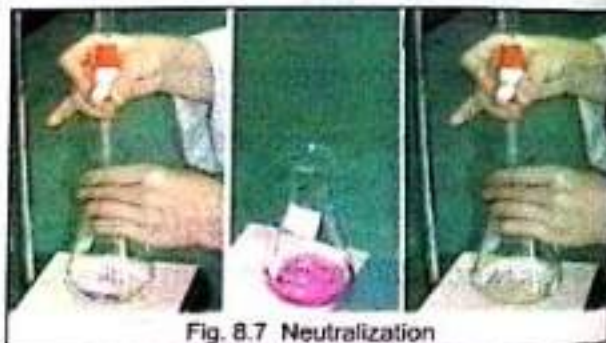
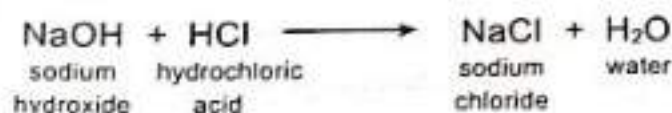


Fig. 8.7 Neutralization

We can conclude that, at this stage (i.e. when the solution becomes colourless) the correct amount of acid has been added to neutralize all the sodium hydroxide molecules.

It is evident that in the presence of phenolphthalein (indicator), when the solution is alkaline, its colour is pink, while the solution is colourless when it is acidic. The effect of adding acid is to remove the basic contents from a solution while of adding alkali is to remove the acidic contents. The resulting solution is neither acidic nor basic because it contains only salt and water.

The equation for this reaction is:



Note that the hydroxyl (OH⁻) group of the base has combined with hydrogen of the acid to form a molecule of water. Sodium chloride or salt is also formed.

If the experiment is repeated with another base (say potassium hydroxide) and another acid (say sulphuric acid) the reaction will be:



Potassium sulphate is a salt. So, here also, an acid and a base react to give salt and water.

The reaction of an acid with a base to form a salt and water is called neutralization.

The reaction gets its name because the acid and the base cancel out each other's properties to produce a solution which is neutral, i.e. it is neither acidic nor basic.



Note that the word 'salt' here does not refer only to common salt (sodium chloride) but is a general term. It refers to the compounds formed when an acid is neutralized by a base.

SALTS

A substance formed by the neutralization reaction of an acid with a base is called a SALT.

Preparation of salts

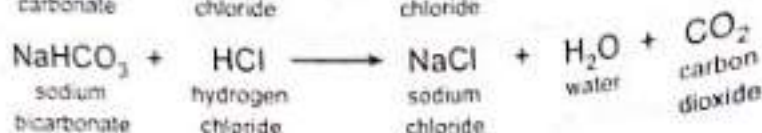
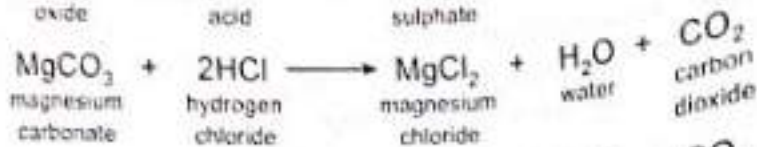
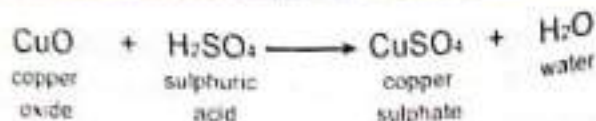
Salts can be prepared by following methods:

□ By neutralization of an acid with a base:



□ By reacting acids with metals, metal oxides, metal carbonate or metal bicarbonates:





□ By the direct combination of a metal with a non-metal:



Uses of Salts

Uses of some common salts are listed under following headings:

1. SODIUM CHLORIDE (NaCl)

Common salt is an essential constituent of our diet. It is used as a preservative for meat, fish etc. It is mixed with ice to get the freezing mixture and in the preparation of pottery glaze. It is also used for the manufacture of chlorine, hydrochloric acid, washing soda, caustic soda and many other compounds.

2. SODIUM CARBONATE (Na_2CO_3)

It is commonly known as **washing soda**. It is used in laundry for washing clothes. It is also used for the preparation of a number of other compounds and material such as glass, caustic soda, borax and detergent powders.

3. SODIUM BICARBONATE (NaHCO_3)

It is commonly called **baking soda**. It is used as baking powder in baking industries. It is used in medicines to neutralize the acidity in the stomach. It is also used in fire extinguishers.

4. POTASSIUM NITRATE (KNO_3)

It is used in the manufacture of gunpowder and in making fire works. It is used in refrigeration, in medicines, in pickling of metals and as fertilizers and also in glass industries.

5. COPPER SULPHATE (CuSO_4)

It is used as a fungicide, in electroplating and dyeing. It is also used in medicines.

6. POTASH ALUM ($\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$)

It is commonly called **phitkari**. It is used in the purification of water, as a mordant in dyeing and for tanning leather. It is also used to stop bleeding from minor cuts.

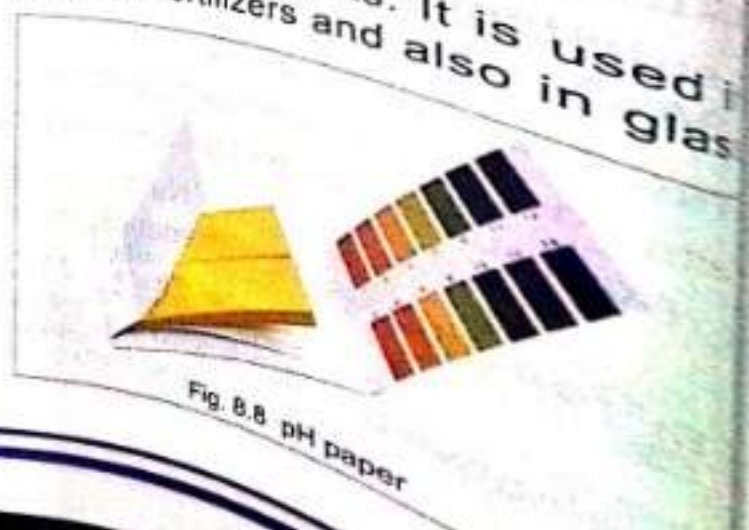


Fig. 8.8 pH paper



Amazing facts!

pH Paper or universal indicator

A pH paper is a strip indicator that can show the acidity or alkalinity of any solution by indicating its pH in the pH range of 1-14. It is prepared by soaking a paper into a mixture of indicators. For every pH, it shows a different color change.

Let's work in team!



Prepare your own acid/base indicator with the petals of china rose flower. Boil its petals in water till water gets some colors. Use this water as an indicator. It will change into green color in alkaline solutions and magenta in acidic solutions.

Teacher's corner



Tell students about various theories proposed by different scientists to explain chemical nature of acids and bases.



KEY POINTS

Here is a list of key points to remember:

- 🔑 Large number of compounds are classified into three groups i.e. acids, bases and salts.
- 🔑 Most fruits have weak organic acids in them.
- 🔑 Properties of acids:
 - ❑ Acids have a sour taste
 - ❑ All acids turn blue litmus solutions and methyle orange solution red.
 - ❑ Acids are compounds that contain hydrogen atoms.
 - ❑ Acids are compounds which form hydronium ions (H_3O^+) in aqueous solution.
 - ❑ Acids react with more active metals to form salts and release hydrogen gas.
 - ❑ Acids react with carbonates and bicarbonates to liberate carbon dioxide.
- 🔑 Acids are used in laboratories and industries for various purposes.
- 🔑 A base is a compound whose molecule is made up of one or more hydroxyl (OH^-) groups attached to a metal atom.
- 🔑 Water soluble bases are called alkalis.
- 🔑 All alkalis are bases but all bases are not alkalis.
- 🔑 Properties of bases:
 - ❑ Bases have a bitter taste.
 - ❑ The solutions of bases have a slippery touch.
 - ❑ Bases turn methyl orange yellow, red litmus turns blue and phenolphthalein pink.
 - ❑ Bases are compounds that contain hydroxyl (OH^-) group.
 - ❑ All bases produce hydroxyl (OH^-) ions in solution.
 - ❑ Bases react with acids to give salt and water.

-  Indicators are the substances that show basic or acidic character of solution by changing their colour.
-  Acids produce carbon dioxide gas with carbonates and bi-carbonates.
-  The number of replaceable hydrogen atoms in an acid is called its basicity.
-  The number of replaceable hydroxyl ions in a base is called its acidity.
-  A reaction between an acid and an alkali that forms salt and water is called a **neutralization reaction**.
-  A substance formed by the neutralization of an acid with a base is called **salt**.
-  There are so many uses of salts in domestic life as well as industries.

KEY WORDS

- Corrosive:** that destroys surfaces such as skin.
- Aqueous:** containing water.
- Aqua regia:** a mixture of hydrochloric acid and nitric acid in the ratio at 3:1, respectively.
- Galvanization:** application of a layer of zinc on steel or iron.
- Fertilizers:** chemicals that are added in the soil to increase growth of plants.
- Celluloid:** a kind of plastic.
- Fungicides:** chemicals that kill fungi.
- Pickling:** removal of impurities from metal surface.
- Tanning:** process of conversion of animal skin into leather.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Give the definition of an acid. Name three mineral acids and state three properties of acids.
2. Define bases. Give three examples and state three properties of bases.
3. Define an alkali. What is the difference between a base and an alkali. Give two examples of alkalis. Also give two examples of bases which are not alkalis.
4. Explain what you understand by basicity of an acid and acidity of a base.
5. Define an indicator. Name three indicators and write the effect of acids and bases on them.

6. How are salts prepared? Name six salts which are commonly used at home.
7. Write two uses of acids, bases and salts.
8. Define a neutralization reaction. Give at least two examples.
9. What happens when an acid reacts with a more active metal.
10. With the help of an activity, show how neutralization takes place between an acid and a base.

B. Fill in the following blanks:

1. Acid reacts with a base to give and
2. Sodium hydroxide is also called.....
3. Acid turns methyl orange
4. NaOH is an example of a
5. Solutions of bases turn litmus into

C. Decide whether the following statements are TRUE/FALSE.

1. The word "Acid" belongs to Greek language.
2. The acids present in food stuff are strong.
3. Bases turn methyl orange pink.
4. Phenolphthalein is used to check purity of acids and bases.
5. Sodium carbonate is commonly known as washing soda.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Choose the most appropriate answer from the following statements:

1. can cause serious skin burns:
a. sulphuric acid
b. citric acid
c. lemon juice
d. acetic acid
2. Acids react with carbonates and bicarbonates to liberate
a. hydrogen
b. carbon dioxide
c. oxygen
d. nitrogen
3. is used in the manufacture of celluloid and artificial silk:
a. sulphuric acid
b. hydrochloric acid
c. nitric acid
d. sodium hydroxide

Formative Assessment - II (Based on Units 5 - 8)

Max. Marks: 25

Time: 30 minutes

A. Short - answer Questions

(12 Marks)

1. Explain briefly why members of a species are different from the members of other species.
2. Summarize the difference between migration and exodus.
3. How does deforestation contribute to the phenomenon of global warming? Explain briefly.
4. In what way are radicals different from molecules?
5. Justify why scientists prefer to use pH paper instead of litmus paper to find out the strength of a solution.
6. Explain why formation of carbon disulphide from carbon and sulphur is called an endothermic process.

B. Balance the following chemical equations:

(02 Marks)

- (a) $\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
- (b) $\text{Pb}(\text{NO}_3)_2 \longrightarrow \text{PbO} + \text{NO}_2 + \text{O}_2$
- (c) $\text{FeCl}_3 + \text{NH}_4\text{OH} \longrightarrow \text{Fe}(\text{OH})_3 + \text{NH}_4\text{Cl}$
- (d) $\text{N}_2 + \text{H}_2 \longrightarrow \text{NH}_3$

C. Group Activity

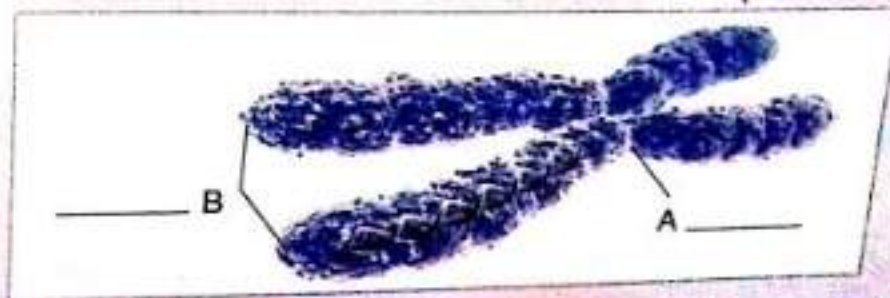
Visit the science laboratory and carry out an experiment to observe reaction of acids with different metals.

(02 Marks)

D. Identify the following diagram and also label the lettered parts on the diagram.

(02 Marks)

This is a diagram of



E. Give one-word answers to the following questions:

(04 Marks)

1. Name the fluid present inside the nucleus of a cell.
2. What is the process of re-planting in an area called?
3. Who was the first scientist to use symbols in place of names of elements?
4. Which acid is found in apples?
5. Which scientist proposed the laws of heredity?
6. What is formed by different populations of an ecosystem?
7. Which substance oxidizes other substances by providing oxygen to them?
8. Which substance is used in the manufacturing of bleaching powder?

F. Multiple Choice Questions

(03 Marks)

1. It is not related to chromosomes:

(a) Genes	(b) Chromatid	(c) Centromere	(d) Zygo
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2. Point out the mismatch in the following options:

(a) Global warming	(b) Ultraviolet rays	(c) Green house effect
(d) Carbon dioxide		
3. It is the correct formula of calcium bicarbonate:

(a) CaCO_3	(b) CaHCO_3	(c) $\text{Ca}(\text{HCO}_3)_2$	(d) Ca_2HCO_3
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4. Which one of the following is not an alkali?

(a) $\text{Al}(\text{OH})_3$	(b) KOH	(c) NaOH	(d) $\text{Ca}(\text{OH})_2$
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5. It is one of the products of fermentation:

(a) Carbon dioxide	(b) Oxygen	(c) Glucose	(d) Sugar
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6. This factor does not affect the population of an area:

(a) Climatic conditions	(b) Famine	(c) War
(d) Excessive use of energy		

Summative Assessment - I

(Based on Units 1-8)

Max. Marks: 80

Time: 2.5 Hours

Section A

(Multiple Choice Questions)

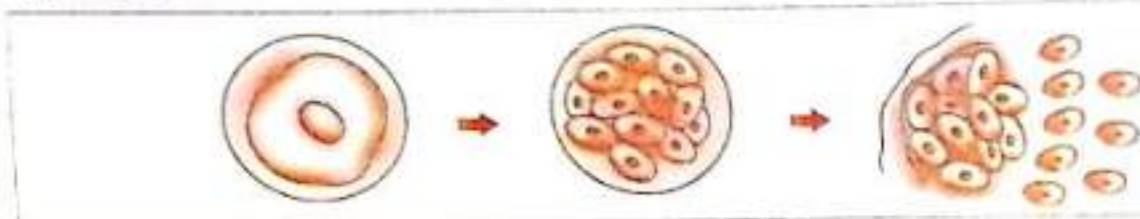
Choose the correct answer.

(10 Marks)

1. The product of photosynthesis is stored in plants in the form of:
(a) Starch (b) Glucose (c) Glycogen (d) Fructose
2. It differentiates osmosis from diffusion:
(a) Permeable membrane (b) Water (c) Oxygen (d) Carbon dioxide
3. It is not a function of ethylene:
(a) Fruit - ripening (b) Stem elongation
(c) Germination of seeds (d) Growth stimulation
4. This plant can be grown through leaves:
(a) Potato (b) Bryophyllum (c) Money plant (d) Strawberry
5. It is responsible for the storage of genetic information about the characteristics of living things:
(a) Chromosome (b) Gene (c) DNA (d) Nucleus
6. Which of the following describes a habitat?
(a) A place of living (b) A place in biosphere
(c) A place in a forest (d) None of them
7. The Latin name of lead is:
(a) Kalium (b) Plumbum (c) Stannum (d) Aurum
8. Which of the following is related to precipitates?
(a) Insoluble (b) Acid (c) Base (d) Neutralization
9. It can cause serious skin burns:
(a) Sulphuric acid (b) Citric acid (c) Lemon juice (d) Vinegar
10. Which of the following is related to gynoecium of the flower?
(a) Ovule (b) Ovary (c) Stigma (d) None of them

Section B (Structured Questions)

1. The following diagram shows a process of asexual reproduction that occurs in some living organisms: (04 Marks)



- (a) Identify the process as _____:
(b) Briefly explain the process in the given space.

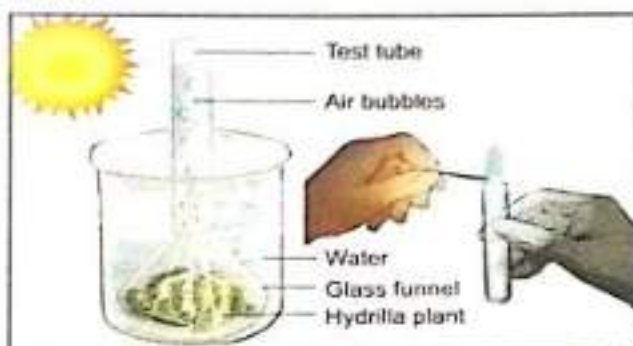
2. Fill in the following table. (04 Marks)

Element	Symbol	Valency
Iron		
Tin		
Sulphur		
Copper		

3. Identify the following picture and explain briefly in the given space what is shown in (04 Marks)



4. Following diagram shows a biological experiment. Identify the experiment and briefly explain it in the given space. (04 Marks)



Section C

A. Short - answer Questions

(24 Marks)

1. Name the organs that make up the alimentary canal.
2. Explain the importance of capillaries in circulatory system.
3. Why is the nervous system regarded as the communication system of the body?
4. Briefly explain how the growth of a plant is different from the growth of an animal.
5. Briefly describe the structure of a chromosome.
6. Differentiate between the terms population and community.
7. Explain the meaning of a redox reaction with the help of an example.
8. Explain what you understand by basicity of acids and acidity of bases.

B. Long - answer Questions

(30 Marks)

1. Define peristalsis. Draw diagrams to show peristalsis.
2. Describe three main parts of a human brain.
3. Define fermentation and describe its various uses.
4. Explain in detail why forests are important for us.
5. With the help of two examples each, differentiate between endothermic and exothermic reactions.
6. With the help of an activity, show how neutralization takes place between an acid and a base.

Carbon and its Compounds

Learning Objectives

At the end of this unit, students should be able to:

- understand occurrence, natural form and common properties of carbon.
- understand and explain the meaning of allotropy.
- list the different allotropes of carbon and describe some of their properties.
- understand and explain the industrial and laboratory preparation of carbon dioxide, its properties, uses and tests.
- learn about some important carbon compounds.
- understand and define hydrocarbons and give some examples.
- understand and explain the occurrence, laboratory preparation, physical and chemical properties and uses of methane.
- understand and describe origin, occurrence, refining and uses of petroleum.
- understand and explain the construction, working and types of fire extinguishers.

OCCURRENCE AND SIGNIFICANCE OF CARBON

Carbon is an important element. It is found naturally, both in the pure form and in combination with other elements. All living matter and almost all materials that support life contain carbon. Proteins, fats, carbohydrates and vitamins are carbon compounds. That is why, carbon is regarded as the central element in the structure of the living world.

In free state, carbon is found in nature as diamond, graphite and coal. In the combined form, it occurs in large quantities in the earth's crust as carbonates. The most important of these is calcium carbonate (CaCO_3), which occurs as limestone and marble.

The fossil fuels—coal, petroleum and natural gas—contain carbon. Coal contains carbon in its free state and petroleum and natural gas contain compounds of carbon and hydrogen only. Such compounds are known as **hydrocarbons**. Carbon occurs in the atmosphere as carbon dioxide. Carbon dioxide forms a very small portion (only 0.03% by volume) of the atmosphere. However, it plays a very significant role in the living world.

Carbon has the unique property of forming a very large number of compounds. There are millions of carbon compounds—more than the compounds of all the other elements put together. More and more carbon compounds are being discovered every day.



Fig. 9.1 Carbon occurs in living as well as non-living matter.



Fig. 9.2 Petroleum

That is why compounds of carbon are studied under a separate branch of chemistry called **organic chemistry**. However, a few carbon compounds, such as carbon dioxide, carbon monoxide and carbonates are studied in **inorganic chemistry**.

FORMS OF CARBON

Carbon exists in two forms:

- crystalline, and
- non-crystalline (or amorphous).

In the crystalline form, the atoms of carbon are arranged in an ordered way while in the non-crystalline form, carbon atoms are arranged haphazardly. Diamond and graphite are crystalline forms of carbon while coal and charcoal are its non-crystalline forms.

ALLOTROPES OF CARBON

Diamond and graphite are the two crystalline forms of carbon. Though these have the same chemical properties, they are very different from each other in their appearance and physical properties. If an element can exist in more than one form, and each form has different physical properties but identical chemical properties, the element is said to exhibit **allotropy**. The different forms of the element are said to be its **allotropes**. Diamond, graphite and amorphous carbon are allotropes of carbon.

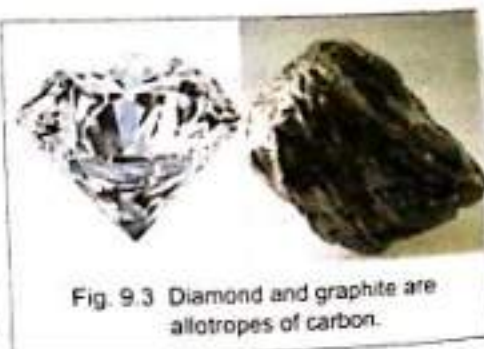
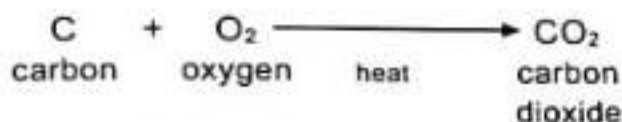


Fig. 9.3 Diamond and graphite are allotropes of carbon.

If equal quantities of the three forms of carbon are completely burnt in oxygen, they give exactly the same quantity of carbon dioxide. No other substance is formed. This shows that diamond, graphite and amorphous carbon are different forms of carbon.



The difference arises because of the difference in the arrangement of carbon atoms in them. While amorphous carbon is non-crystalline, the arrangement of atoms in the crystals of diamond and graphite is different from each other.

Phosphorus and sulphur are other elements that exhibit **allotropy**.

DIAMOND

Structure: In diamond, each carbon atom is joined with strong forces to four other carbon atoms. This results in a three-dimensional rigid structure (Fig. 9.4). The structure is so stable that it makes **diamond the hardest known substance**.

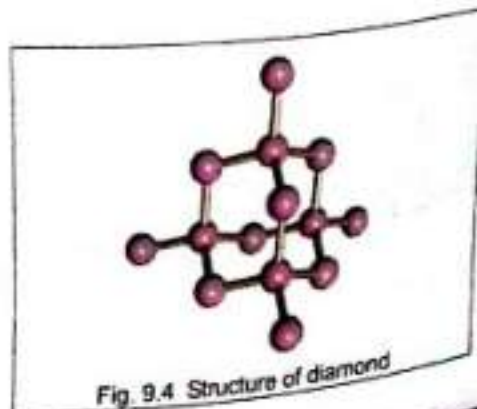


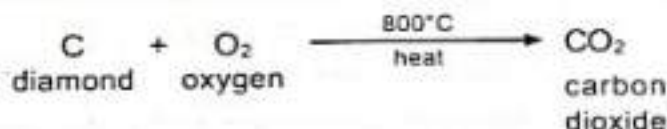
Fig. 9.4 Structure of diamond

Occurrence: Diamond is formed from carbon deep inside the surface of the earth, at depths of over 150 km. At this depth, the temperature and pressure are very high. These conditions convert carbon to diamond. Diamonds reach the surface of the earth along with other rocks during volcanic eruptions.

South Africa is the largest producer of diamonds in the world.

Properties

- ❑ Diamond is the **hardest substance among all substances**. It can only be cut by another diamond.
- ❑ Pure diamond is **colourless and transparent**. The colour in some diamonds is due to the presence of small amount of impurities in them.
- ❑ Diamond is a non-metal and that is why it is a **bad conductor of heat and electricity**.
- ❑ Diamond has a density of 3.5 g/cm^3 .
- ❑ Diamond **sharply bends light rays** passing through it. When it is cut along certain planes called **cleavage planes**, these rays of light get reflected from these planes. This is the reason why a cut and polished diamond has a bright lustre.
- ❑ Diamond does not normally react with any chemical. However, when heated to 800°C in oxygen, it burns to give carbon dioxide.



Good to know

Diamond is graded on the basis of its clarity. Diamonds with less impurity are more clear and more valuable. Gemological Institute of America (GIA) has developed an international grading system which is used to classify clarity of diamond from flawless (FL) to prominent inclusions (I3).

Uses of diamond

- ❑ Due to its lustre, diamond is used in jewellery as a precious stone.
- ❑ Due to its hardness, diamond is used in tools for cutting glass and drilling rocks.



Fig. 9.5 Diamonds with different clarity

GRAPHITE

Structure: In graphite, the carbon atoms are arranged in layers (Fig. 9.6). Within each layer, one carbon atom is joined with strong forces to three other carbon atoms. However, the atoms in one layer are very loosely joined to the atoms in the adjacent layer. This enables the layers to slip over each other. That is what makes graphite soft and slippery to touch.

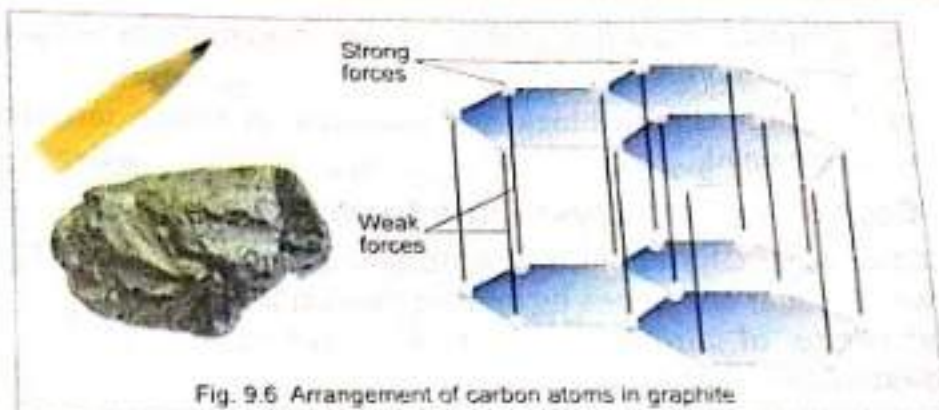


Fig. 9.6 Arrangement of carbon atoms in graphite

OCCURRENCE

Graphite is found in China, India, Brazil, Srilanka and Canada. It occurs in the forms of shiny hexagonal crystals.

Properties

- Graphite is dark grey in colour and soft and greasy to touch.
- Graphite is a good conductor of electricity.
- Graphite has a density of 2.25 g/cm^3 and a high melting point of 3700°C .
- Graphite burns in oxygen when heated to 700°C and produces carbon dioxide.

Uses of graphite

- Being soft and slippery, graphite is used as a lubricant. Since it can withstand high temperature, it is specially useful as a lubricant in fast-moving machines, where high temperature makes other lubricants unsuitable.
- Graphite can conduct electricity, can withstand high temperatures and is not easily attacked by chemicals. Therefore, it is used to make electrodes for electric furnaces, in electroplating and in dry cells.
- Graphite leaves marks on paper, as the loosely stacked layers are left behind on the paper due to friction. It is, therefore, used to make the 'lead' in pencils.
- Due to its high melting point, graphite is used to make crucibles (small containers) for melting some metals.

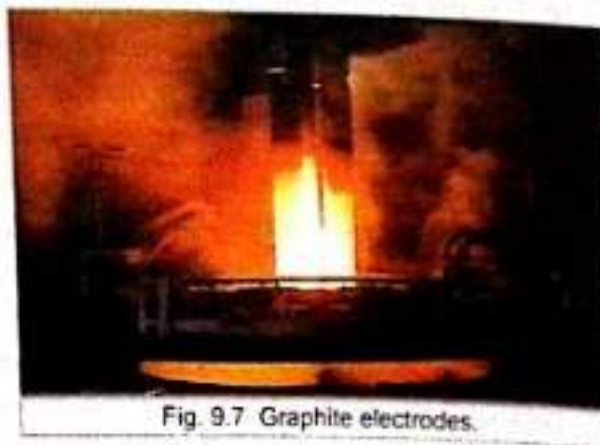


Fig. 9.7 Graphite electrodes.

- Graphite is used to make artificial diamonds by subjecting it to high pressure and temperature.
- Graphite, being black and insoluble in water, is used to make printer's ink and black paint.

Carbon in non-crystalline form

Charcoal: Charcoal can be obtained from wood, sugar and bones by heating them in the absence of air. This process is called **destructive distillation**.

During destructive distillation, the gases and the low boiling point liquids escape, leaving behind charcoal. Depending on the source, the charcoal is known as wood charcoal, sugar charcoal, or bone charcoal.

Wood charcoal can be produced in the laboratory by heating wood shavings in the absence of air.

Uses of charcoal

Wood charcoal is a black and porous solid. It has the property of absorbing gases. It is therefore, used in gas masks. It is also used in water filtration plants and as a fuel.



Fig. 9.8 Bone charcoal



Fig. 9.9 Wood charcoal

ACTIVITY TIME! To prepare wood charcoal.

Take wood shavings in a hard glass test tube and water in another test tube. Set up the apparatus as shown in Figure 9.10 using two delivery tubes. Heat the wood shavings with a bunsen burner. You will observe bubbles of gas coming out of the delivery tube dipped in water. Black-coloured drops of wood tar will settle below the water. The gas coming out through the open delivery tube can be burnt using a matchstick. The gas is called **wood gas** and contains mostly carbon monoxide (CO). When the bubbles of gas stop coming out, stop the heating. Remove the tube that is dipped in water before the apparatus cools down. Take out the residue in the hard glass test tube after the apparatus has cooled down. It is called wood charcoal.

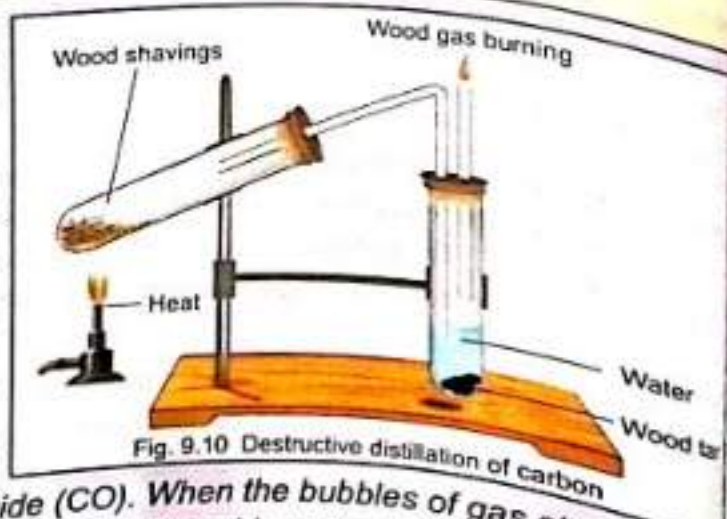
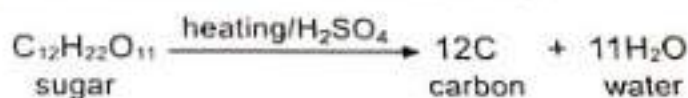


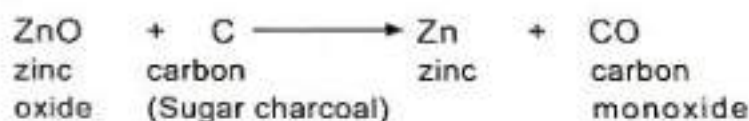
Fig. 9.10 Destructive distillation of carbon

Animal charcoal has the property of absorbing coloured matter. It is therefore, used in industry as a decolourizing agent. For example, during the manufacture of sugar, it is used to remove brown colour from sugar.

Sugar charcoal is a very pure form of carbon. It is made by the destructive distillation of sugar, which drives out the water, leaving behind pure carbon. It can also be made by removing water from sugar by using sulphuric acid. (H_2SO_4)



Sugar charcoal is mainly used to obtain metals from their oxides.



Lamp black: Lamp black is formed when carbon-rich substances such as petrol, turpentine oil, wax, paraffin oil, etc. are burnt in a limited supply of air. It is used as a colouring matter in the preparation of black shoe polish, carbon paper, printing ink, black paints, etc. It is also used in the manufacture of tyres and in the manufacture of gun powder.

ACTIVITY TIME! To make lamp black at home.

Burn mustard oil or **ghee** in a lamp and hold a plate over it as shown in the (Fig. 9.11).

The black mass deposited on the inside of the plate is lamp black. **Kajal**, which is applied to eyes, is lamp black and is made in the same way.

Lamp black deposited on the plate



Fig. 9.11 Making lamp black at home

Coke: Coke is made by the destructive distillation of coal. The gases and other substances present in coal are given off on heating. The black residue left behind is coke.

Coke is used as a fuel. It does not give off smoke and it is, therefore, a cleaner fuel than coal. It is also used to obtain metals from their oxides.

Fullerenes

Fullerenes are unique molecular forms of pure carbon discovered in 1985. They appear as cage-like structures of carbon atoms, the most abundant form being **buckminsterfullerene**

(C_{60}), with 60 carbon atoms arranged in a spherical structure. There are larger fullerenes containing 70 to 500 carbon atoms. While diamond and graphite are crystalline in nature, fullerenes form discrete particles. The C_{60} molecule looks like a soccer ball. It is also called 'a bucky ball'.

Good to know

A new form of carbon called carbon nanotubes has been discovered in 1991. They are 100 times stronger than steel but only 1/6 times heavy. They can strengthen any material and can conduct electricity better than copper.

Chemically, fullerenes are quite stable; breaking of their balls requires temperatures of over 1000°C . Fullerenes are fascinating because they show unusual properties. For example, adding 3 alkali atoms per C_{60} results in a material which becomes superconducting at quite a high temperature.

When fullerenes were first discovered, there was much excitement about their practical applications. It was

thought that bucky balls would make great lubricants, rolling like little ball bearings between other molecules, or perhaps drugs could be trapped inside the cages, and then released slowly by breaking open the balls inside the body, using a triggering mechanism.

However, no commercial applications of fullerene molecules have been found as yet. Development is going on, and it is only a matter of time before their useful applications are discovered.



Fig. 9.12 Molecular structure of a fullerene

COMPOUNDS OF CARBON AND OXYGEN

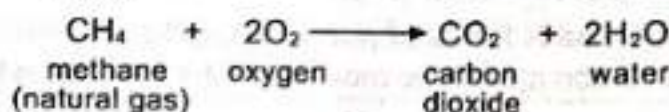
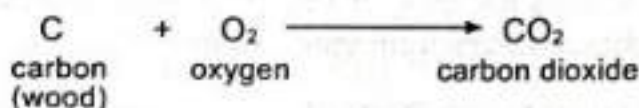
CARBON DIOXIDE

Have you ever wondered what causes the fizz in aerated cold-drinks? The answer is the carbon dioxide gas dissolved in the drink under pressure. Carbon dioxide is also used by plants during photosynthesis.

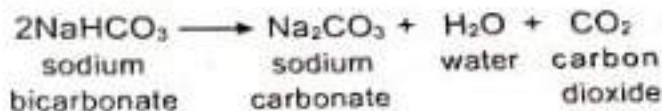
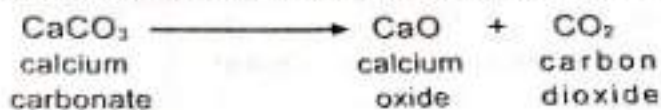
Occurrence: The percentage of carbon dioxide in air is 0.03. It is produced naturally during combustion, respiration and decay of organic matter.

Preparation: Carbon dioxide can be prepared by the following methods:

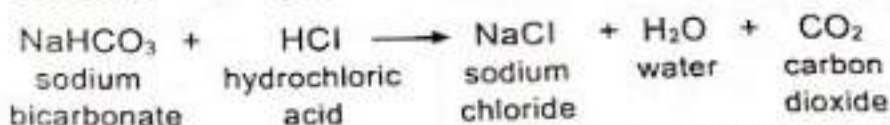
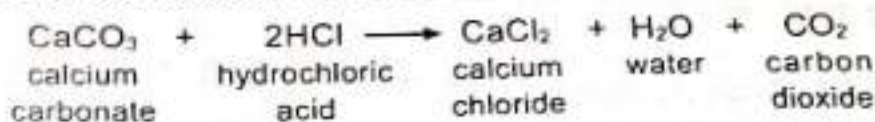
- By burning carbon or carbon compounds in air.



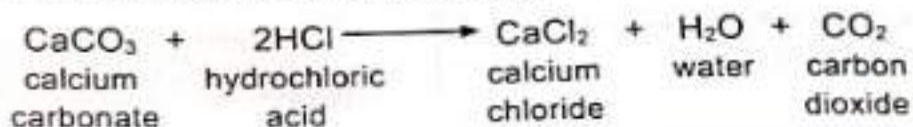
- By the action of heat on certain metallic carbonates and bicarbonates.



- By the action of dilute acids on carbonates and bicarbonates.



Laboratory preparation: Carbon dioxide is prepared in the laboratory by the action of dilute hydrochloric acid on marble chips (CaCO_3).



ACTIVITY TIME! To conduct laboratory preparation of carbon dioxide.

Put some marble chips in a Woulfe's bottle. Using a thistle funnel, a delivery tube and a gas jar, set up the apparatus as shown in Figure 9.13. Remember that the apparatus should be air tight, and the end of the thistle funnel should be inside the chips.

Pour dilute acid through the thistle funnel. As soon as the acid comes in contact with the marble chips, bubbles of carbon dioxide are produced. Being heavier than air, carbon dioxide is collected in the jar by the upward displacement of air. Dilute nitric acid can also be used instead of dilute hydrochloric acid.

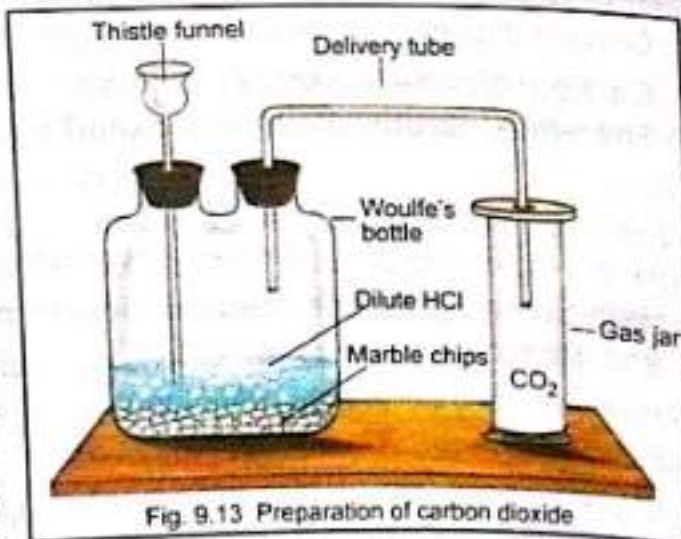


Fig. 9.13 Preparation of carbon dioxide

Physical properties of carbon dioxide

- Carbon dioxide is a colourless and odourless gas.

- Carbon dioxide is about 1.5 times denser than air.
- Carbon dioxide is slightly soluble in water. Its solubility increases considerably under pressure.
- When cooled, carbon dioxide freezes at -57°C at standard atmospheric pressure to form a white solid known as **dry ice**.



Fig. 9.14 Dry ice

ACTIVITY TIME! To show that carbon dioxide is heavier than air.

Take a gas jar full of carbon dioxide and another with air in it. Place a small burning candle at the bottom of the gas jar containing air. Now bring the gas jar containing carbon dioxide above the mouth of the other jar and invert it. Carbon dioxide, being heavier than air, flows down into the lower jar and extinguishes the candle (Fig. 9.15).

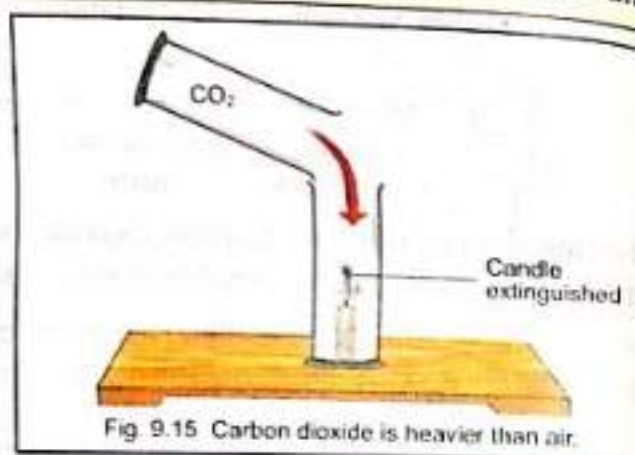
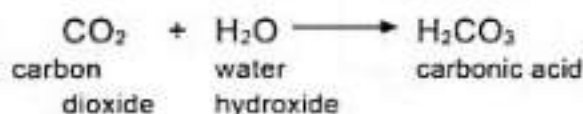


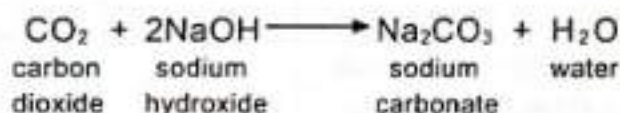
Fig. 9.15 Carbon dioxide is heavier than air.

CHEMICAL PROPERTIES OF CARBON DIOXIDE

- Carbon dioxide neither burns nor supports combustion.
- Carbon dioxide dissolves in water to form a weak acid called **carbonic acid**. Therefore, **carbon dioxide is called an acidic oxide. It turns blue litmus red.**



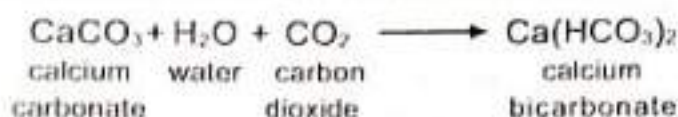
- Being an acidic oxide, carbon dioxide reacts with alkalis to form salt (carbonates) and water.



- Lime water is a clear solution containing calcium hydroxide $[\text{Ca}(\text{OH})_2]$. If carbon dioxide is bubbled through lime water, it turns milky due to the formation of insoluble calcium carbonate. This reaction is used as a test for carbon dioxide.



If more carbon dioxide is bubbled through the solution, the milkiness disappears due to the formation of calcium bicarbonate which is soluble in water.



- During photosynthesis, carbon dioxide of the air reacts with water in the presence of sunlight and chlorophyll to produce glucose.



Uses of carbon dioxide

- It is used in aerated drinks to give them a tangy taste.
- Since carbon dioxide does not support combustion, it is used in fire extinguishers.
- Dry ice is used for refrigeration.
- Carbon dioxide is used in the manufacture of sodium carbonate (washing soda) and sodium bicarbonate (baking soda).
- Plants use carbon dioxide to manufacture food by photosynthesis.
- Carbon dioxide is used in the manufacture of urea, a nitrogen-containing fertilizer.

CARBONATES AND BICARBONATES

Sodium carbonate (Na_2CO_3): Sodium carbonate is known as **soda ash**. It is used in the manufacture of glass, wood pulp and paper, in textile processing and softening of hard water.

Calcium carbonate (CaCO_3): Calcium carbonate is found in nature as limestone and marble. Marble is an important building material. Limestone is used for whitewashing buildings.

Sodium bicarbonate (NaHCO_3): It is commonly known as **baking soda**. It is used in the manufacture of baking powder, health salts and antacid tablets. Baking powder is a mixture of baking soda and a weak acid. It is added to cakes and bread. On being heated, the two components react to form carbon dioxide which makes the cakes and bread fluffy.

Antacid tablets containing sodium bicarbonate relieve acidity because sodium bicarbonate neutralizes the acid in the stomach by reacting with it. Health salts are used to remove constipation.

COMPOUNDS OF CARBON WITH HYDROGEN

Hydrocarbons are compounds of carbon and hydrogen only. They are the simplest, yet an important class of organic compounds. Fuels, such as petrol, diesel, CNG and natural gas, are mixtures of hydrocarbons.

The simplest hydrocarbon is methane (CH_4). It contains only one carbon atom. A

hydrocarbon with two carbon atoms is **ethane** (C_2H_6) and the one with three carbon atoms **propane** (C_3H_8). As the number of carbon atoms increases, we get **butane** (C_4H_{10}), **pentane** (C_5H_{12}), and other hydrocarbons, in the form of a series known as **alkanes**.

Carbon atoms can form different types of chains and can also get linked to each other in the form of rings. This ability of carbon atoms to form long chains and rings is one of the important reasons why carbon can form such a large number of compounds. No other element has this ability.

Other than alkanes, carbon combines with hydrogen in different ways to form a number of other series of hydrocarbons. It also forms series of compounds with other elements as well.

In a hydrocarbon series, there is a gradual change in the physical properties, such as density, melting point and boiling point (Table 9.1). The first four alkanes are gases. The next thirteen are liquids and the rest are solids.

Table 9.1. Properties of some hydrocarbons

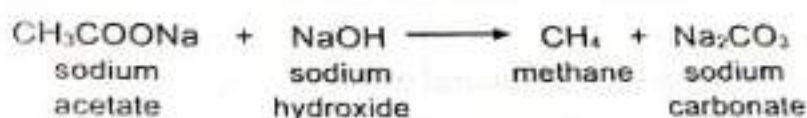
Name	Formula	Melting point ($^{\circ}C$)	Boiling point ($^{\circ}C$)	State at normal temperature	Calorific value (kJ/kg)
methane	CH_4	-182	-161	gas	55000
ethane	C_2H_6	-183	-89	gas	50000
propane	C_3H_8	-188	-42	gas	50000
butane	C_4H_{10}	-138	0	gas	50000

Hydrocarbons are used as fuels. **Methane** forms a large percentage of natural gas. **Butane** is liquefied under pressure, filled in cylinders and used as liquefied petroleum gas (LPG). Since butane has no smell, it is mixed with a small amount of a smelling agent such as hydrogen sulphide. This enables any leakage of the gas to be easily detected by the smell. **Octane** (C_8H_{18}) is an important constituent of petrol.

METHANE

Occurrence: Methane is the chief constituent of natural gas, which contains over 80% methane. Since methane is formed by the decomposition of animal and vegetable matter in marshy places, it is called **marsh gas**. Biogas, formed by the decomposition of animal and plant wastes, mainly contains methane.

Laboratory preparation: Methane is obtained in the laboratory by heating a mixture of equal amounts of sodium acetate and soda lime. **Soda lime** is a mixture of sodium hydroxide and calcium oxide. The sodium hydroxide present in it reacts with sodium acetate to give methane.



Methane, being insoluble in water, can be collected by the downward displacement of water (Fig. 9.16).

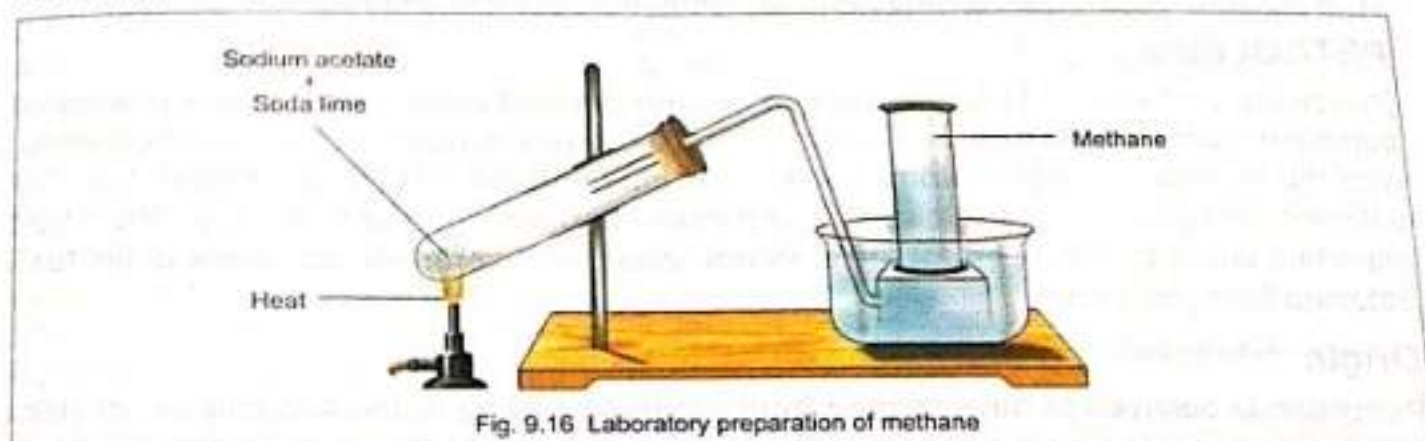


Fig. 9.16 Laboratory preparation of methane

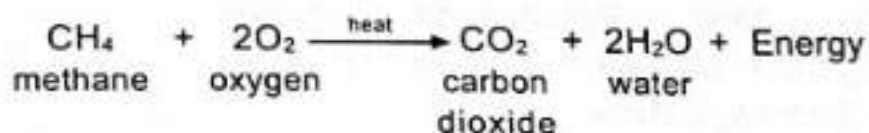
Physical properties of methane

Methane is

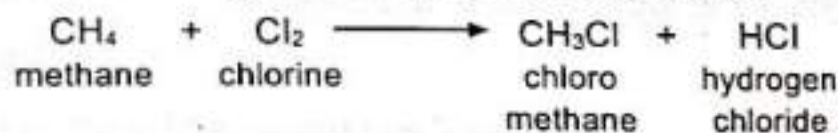
- It is a colourless and an odourless gas.
- It is insoluble in water.
- It is lighter than air.

Chemical properties of methane

- Methane burns in air with a bluish flame to produce carbon dioxide and water and release a large amount of heat.

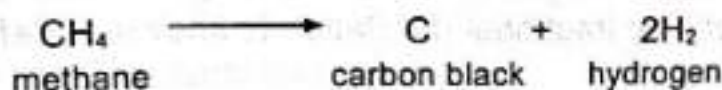


- Methane reacts with chlorine gas in the presence of sunlight.



Chlorine may displace all the four hydrogen atoms from methane and we get carbon tetrachloride (CCl_4), a very useful industrial solvent.

- Methane burns in the absence of oxygen to form carbon black.



Uses of methane

- It is used as a fuel in the form of natural gas and biogas.
- It is used in the manufacture of carbon black which is used for preparing paints and in the tyre industry.
- It is used for the preparation of a large number of organic compounds.

PETROLEUM

Petroleum or crude oil is found trapped in underground rocks. This is why it is called petroleum (petra means rock, and oleum means oil). It is a mixture of several hydrocarbons, with the number of carbon atoms in the molecule varying from 1 up to over 100. The different compounds in petroleum are separated and used in various ways. Their most important use is being important fuels. Petrol, diesel and kerosene are some of the fuels obtained from petroleum.

Origin

Petroleum is believed to have formed from organisms living in the sea millions of years ago. As these organisms died, their bodies settled on the sea bed, and were covered with sand and clay. Over millions of years, heat and pressure changed the dead organisms into petroleum. Petroleum is called a fossil fuel as it is derived from the dead bodies of extinct organisms.

Occurrence

Petroleum and natural gas are often found together as large deposits deep inside the earth's crust. Petroleum is obtained by drilling through the earth's crust (Fig. 9.17). The world's first oil well to yield petroleum was dug in Pennsylvania, USA, in 1859. In Pakistan, oil is obtained from oil wells in Pothwar plateau, Khor, Dhullian, Khot Mayyal, Dhodhak, Badin and Hyderabad.

The crude oil pumped out from a well is a black liquid. Because of its importance in today's world, it is referred to as **black gold**.

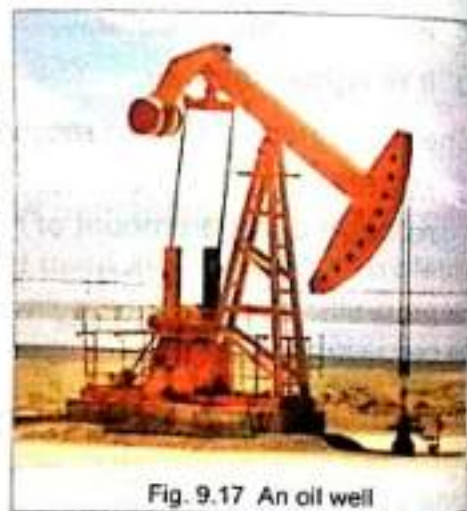


Fig. 9.17 An oil well

Refining of petroleum

The various hydrocarbons in petroleum have different boiling points. As the number of carbon atoms in a hydrocarbon increases, its boiling point also increases. This property is used to separate different components of petroleum by **fractional distillation**. The components with different boiling points are known as **fractions**, and the process of separating these fractions by fractional distillation is known as **refining**. It is carried out in a petroleum refinery.

Crude oil is first heated to about 400°C in a furnace. The oil vapours formed are passed into a tall fractionating column (Fig. 9.18). The hydrocarbons with the highest boiling point condense first. They are collected near the base of the fractionating column. As the vapour rises, the hydrocarbons with lower boiling points condense at different heights. They get separated in the fractionating column to form the different fractions. The hydrocarbons with 1-4 carbon atoms, which are gases, do not condense and escape from the top of the column.

Each fraction obtained from fractional distillation is itself a mixture of several hydrocarbons. Some of these are used as they are. Others are further separated by fractional distillation or other methods to give different products. Some important petroleum fractions and their uses are given in Table 9.2.

Table 9.2. Some important petroleum fractions and their uses.

Fraction	Boiling point	Number of carbon atoms	Uses
Petroleum gas	below 40°C	1-4	fuel (including LPG)
Gasoline and naphtha	40°C – 160°C	4-10	petrol, raw material for making other chemicals
Kerosene	160°C – 250°C	10-16	domestic fuel, jet engine fuel
Light gas oil	250°C – 300°C	16-20	diesel
Heavy gas oil	300°C – 350°C	20-25	making other chemicals
Residue	over 350°C	over 25	further distilled to give fuel oil, lubricating oil, paraffin wax and asphalt

Uses of petroleum

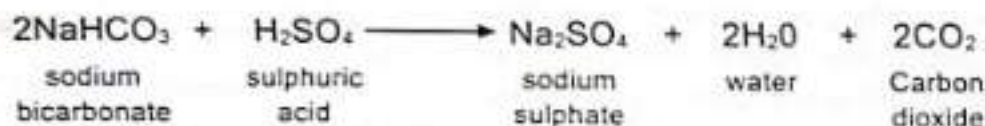
- ▣ Petroleum products are primarily used as fuels.
- ▣ Lubricating oils derived from petroleum are used to lubricate machinery.
- ▣ Paraffin wax is used for manufacturing candles, vaseline, grease, polish, etc.
- ▣ Some chemicals obtained from petroleum are used to make medicines, ointments and cosmetics.
- ▣ Asphalt (bitumen) is used for surfacing roads.

- Further fractional distillation of petroleum fractions yields chemicals used to manufacture plastics, synthetic rubber, synthetic fibres, explosives, etc.

Working of fire extinguishers

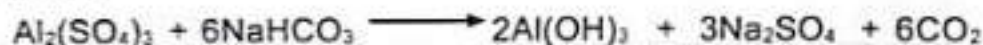
Most fire extinguishers use carbon dioxide to extinguish fires. Carbon dioxide, being heavier than air, surrounds the combustible substance and cuts off the air supply. As carbon dioxide itself is a non-supporter of combustion, it effectively extinguishes the fire. A soda-acid fire extinguisher throws out a mixture of carbon dioxide and water towards the fire. The water cools the combustible substance.

The soda-acid fire extinguisher consists of a metal container filled with a solution of sodium bicarbonate. A glass bottle, kept inside the container, has sulphuric acid in it. When the knob of the extinguisher is pressed, the bottle breaks. The acid comes in contact with sodium bicarbonate and carbon dioxide is produced.



The carbon dioxide comes out through the nozzle which is directed towards the fire (Fig. 9.19).

The **foam-type fire extinguisher** releases a foam of carbon dioxide which surrounds the combustible substance and cuts off its air supply. It is similar in construction to the soda-acid fire extinguisher, but contains aluminium sulphate in the glass bottle instead of sulphuric acid. The reaction that occurs on breaking the glass bottle is as follows:



A substance called **saporin** is added to the sodium bicarbonate solution to produce a foam of carbon dioxide.

This fire extinguisher can be safely used to extinguish petrol and kerosene fires.

In a **carbon tetrachloride fire extinguisher**, vapours of carbon tetrachloride, a non-supporter of combustion, are released on the burning substance. The vapours settle on the combustible substance and cut off its air supply.

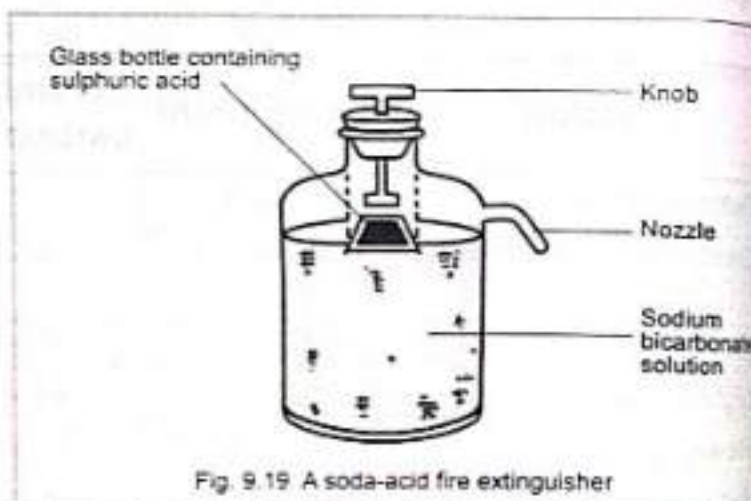


Fig. 9.19 A soda-acid fire extinguisher

 Amazing facts!**Facts about the diamonds**

- ▣ The word diamond comes from the Greek term 'adamas', which means 'unconquerable'.
- ▣ Synthetic, or man-made diamonds became common in 1955, when the General Electric Company used laboratory equipments to subject graphite to great pressure and heat.
- ▣ The weight of diamond is expressed in metric carats. One carat equals one fifth of a gram.

Let's work in team!

Study individually and make a note on importance of carbon for living organisms. Discuss the note with other students and teachers to get a better understanding.

Teacher's corner

Conduct a class presentation in which inform students about the process of formation of petroleum in the earth's crust.

 KEY POINTS

Here is a list of key points to remember:

- 🔑 Carbon is the central element in the structure of the living world.
- 🔑 Carbon forms a large number of compounds which are mostly studied in organic chemistry.
- 🔑 In the crystalline form, carbon exists as graphite and diamond. Amorphous carbon is the non-crystalline form of carbon.
- 🔑 Diamond has a rigid crystalline structure which makes it the hardest substance among all substances. It is, therefore, used to make cutting and drilling tools.
- 🔑 Cut and polished diamond is very lustrous. It is, therefore, used in jewellery as a precious stone.
- 🔑 In graphite, carbon atoms are arranged in layers which are loosely joined with each other.
- 🔑 Graphite is a good conductor of electricity and has a high melting point.
- 🔑 Graphite is used as a high temperature lubricant, as electrodes, in making crucibles, for making the lead in pencils, for making artificial diamonds and for making printers ink and black paint.
- 🔑 Amorphous carbon exists as charcoal (wood, animal and sugar charcoal), lamp black, coal and coke.
- 🔑 Fullerenes are cage-like structures of carbon atoms arranged in a spherical structure.

- 🔑 The proportion of carbon dioxide in air is 0.03% by volume.
- 🔑 Carbon dioxide is prepared in the laboratory by the action of dilute hydrochloric acid on marble chips (calcium carbonate).
- 🔑 Carbon dioxide is colourless, odourless, denser than air and slightly soluble in water. It freezes at -57°C to form dry ice.
- 🔑 Carbon dioxide neither burns and nor supports combustion.
- 🔑 Carbon dioxide is an acidic oxide. It dissolves in water to form carbonic acid. It reacts with alkalis to give salts (carbonates) and water.
- 🔑 Carbon dioxide turns lime water milky by forming insoluble calcium carbonate.
- 🔑 Carbon dioxide is used in aerated drinks, in fire extinguishers, in refrigeration (in the form of dry ice), during photosynthesis by plants, and in the manufacture of sodium carbonate, sodium bicarbonate and urea.
- 🔑 Some common carbonates and bicarbonates are sodium carbonate (soda ash), calcium carbonate (limestone, marble and chalk) and sodium bicarbonate (baking soda). They are used for various purposes.
- 🔑 Fuels are substances that burn in air to produce heat and light. Hydrocarbons are an important class of fuels. They are compounds of carbon and hydrogen only.
- 🔑 Methane (CH_4) is the simplest hydrocarbon. Methane, ethane (C_2H_6), propane (C_3H_8),... form a series of carbon compounds with gradual change in physical properties.
- 🔑 Methane, the chief constituent of natural gas, is prepared by heating sodium acetate and soda lime. It burns with a blue flame to give carbon dioxide and water.
- 🔑 Petroleum is found trapped in underground rock.
- 🔑 Petrol, diesel and kerosene are some of the fuels obtained from petroleum.
- 🔑 Petroleum is called a fossil fuel as it is derived from the dead bodies of extinct organisms.
- 🔑 The various hydrocarbons in petroleum are separated by fractional distillation.
- 🔑 Most fire extinguishers use carbon dioxide to extinguish fires.

KEY WORDS

Proteins:	food components that are mainly obtained from meat.
Carbohydrates:	food components that are mainly obtained from grains, fruits and vegetables.
Fats:	food components that are mainly obtained from animal fat and vegetable oil.

Cleavage:	a sharp division.
Lubricant:	a substance which makes the movement of parts of engine easy.
Destructive Distillation:	decomposition of substance by heating it in a closed container.
Marsh:	an area with shallow muddy water.
Fraction:	a tiny part.
Synthetic:	man-made.
Saporin:	a kind of protein used in biological researches.

**TEST YOUR KNOWLEDGE****A. Answer these questions:**

1. What do you know about the occurrence of carbon in nature?
2. What do you know about allotropy. Name two allotropes of carbon.
3. What conditions are necessary for the formation of diamond? How are they achieved in nature?
4. Point out atleast three ways in which diamond differs from graphite.
5. Write down two important properties of graphite and diamond each. Discuss their uses.
6. What is destructive distillation? What products are formed when wood is subjected to the destructive distillation?
7. Give two methods by which sugar charcoal can be made from sugar.
8. Give one method by which carbon dioxide can be prepared in the laboratory. Draw a labelled sketch of the apparatus used and give equation of the reaction involved in the process.
9. How can you show that carbon dioxide is denser than air?
10. State four physical and four chemical properties of carbon dioxide.
11. Why is carbon dioxide considered to be so useful for extinguishing fires? Describe the working soda-acid fire extinguisher.

12. Write atleast four uses of carbon dioxide.
13. Give the important uses of the following:
 - a. sodium carbonate
 - b. calcium carbonate
 - c. sodium bicarbonate
14. How can carbon form a large number of compounds?
15. Why is methane also called marsh gas? Write down at least two physical properties and one chemical property of methane.
16. Draw a labelled diagram to show how methane can be prepared in the laboratory. Write down the equation of the reaction involved.
17. What is fractional distillation? What fractions of petroleum are obtained by fractional distillation?
18. What do you know about fullerenes?

B. Fill in the following blanks:

1. Two forms of the same element, which have different physical properties but identical chemical properties are called
2. Diamond and are crystalline allotropes of
3. The solubility of carbon dioxide in water can be increased by increasing
4. Each carbon atom in graphite is strongly bounded to carbon atoms.
5. Soda lime is a mixture of sodium hydroxide and
6. Petroleum products are primarily used as
7. Petrol is obtained from crude oil by the process of
8. Gasoline and kerosine are two important fractions of
9. Soda acid fire extinguisher is based on the principle of
10. The important chemical used in fire extinguisher is

C. Decide whether the following statements are TRUE/FALSE:

1. Pure diamond can occur in several colours.
2. Carbon dioxide turns lime water milky.
3. Carbon atoms form chains which can extend to thousands of atoms.
4. Graphite is the hardest form of carbon.
5. LPG means Liquid Petroleum Gas.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Give one-word answers of these questions:

1. Limestone and marble consist of the same compound. Name the compound.
2. Name a gas which, though a compound of carbon, is not studied under organic chemistry.
3. Give another word for non-crystalline.
4. In which allotrope of carbon, carbon atoms are arranged in loosely-bound layers?
5. Name the process by which wood charcoal can be made from wood.
6. Which form of charcoal can absorb colouring matter?
7. Which is the purest form of charcoal?
8. Carbon is used to increase the durability of tyres. What form of carbon is used for this purpose?
9. Name the solid fuel, made from coal, which is less polluting than coal.
10. Which acid is responsible for the tangy taste of aerated drinks?
11. What is solidified carbon dioxide commonly known as?
12. Give the chemical names of baking soda and soda ash.
13. Name the gas which is the chief constituent of both natural gas and biogas.
14. Write the chemical formula and name of the hydrocarbon which contains three carbon atoms.

E. Choose the most appropriate answer for the following statements:

1. A hydrocarbon is a:
 - a. carbon found in nature in the free state.
 - b. carbon found in nature in the form of carbonates.
 - c. compound of only carbon and hydrogen.
 - d. compound of carbon found in living matter.
2. Which form of carbon is a good conductor of electricity?
 - a. graphite
 - b. diamond
 - c. coke
 - d. amorphous carbon
3. Destructive distillation means:
 - a. destroying the crystalline structure of a substance by some means.
 - b. heating the substance very strongly.
 - c. subjecting the substance to high temperature and pressure.
 - d. heating the substance in the absence of air.
4. Which form of carbon burns in oxygen to give carbon dioxide?
 - a. coal
 - b. graphite
 - c. diamond
 - d. all of these
5. Which gas constitutes LPG which we use as fuel in our homes?
 - a. methane
 - b. ethane
 - c. propane
 - d. butane

Homework Assignment



Study and write a note on the role of respiration, combustion, and photosynthesis in maintaining carbon balance in nature.

FUN WITH SCIENCE

Under the supervision of your teacher/instructor, learn the use of fire extinguisher and practice it on fire:-

Synthetic Materials and Chemical Industries

Learning Objectives

At the end of this unit, students should be able to:

- understand and outline the methods adopted to convert the common raw materials into useful products.
- give examples of man-made materials and state how they are useful to us.
- understand and briefly outline the manufacture of soap, detergents and fertilizers.

INTRODUCTION TO SYNTHETIC MATERIALS

There are various types of materials around us. Some are **natural** and some are **man-made**. We use these materials to meet our basic needs of food, clothing, shelter, communication, transportation, recreation, health and hygiene.

You are very familiar with many naturally-occurring materials like cotton, wool, wood, coal, petroleum, minerals etc. These are used for different purposes. The availability of these natural materials is limited. The human population is increasing day by day. For such a large population, we can not depend upon natural products only. Therefore, a number of substances such as rayon, nylon, bakelite, glass, cement, fertilizers, pesticides, soaps and detergents have been made by chemical processes. They are said to be man-made, or synthetic materials. Synthetic materials are obtained by the chemical reaction of two or more substances:

MANUFACTURING PROCESS-RAW MATERIAL AND USEFUL PRODUCTS

As you know that there are thousands of raw materials around us. We are using most of them as starting material to make many other things for our need and comfort. There are three common types of processes which may be adopted to convert the common raw materials into useful products:

- By bringing a change in the shapes of raw materials
- By mixing different raw materials
- By bringing chemical changes in raw materials by chemical reactions

(i) By bringing a change in the shapes of raw materials

For example, metals, wood and stones are



Fig. 10.1. Raw materials can be converted into useful products.

given different shapes and useful things, like utensils, tools, ornaments, wires, vehicles, equipments, furniture, buildings etc. are made from them.

(ii) By mixing different raw materials

Different substances are mixed together in a specific ratio to prepare mixtures. For example, syrups, medicines, drinks, toothpaste, washing powder, butter, spices, ..., etc. Common fizzy drinks are solutions of different chemicals in water. Salts, flavouring concentrates, sugar, colours, preservatives and carbon dioxide gas are dissolved in water to prepare these drinks.



Fig. 10.2 Metallic tools and utensils



Fig. 10.3 Syrup is a synthetic material.

(iii) By bringing chemical changes in raw materials

The common raw materials are converted into useful products by chemical reactions. For example, soaps, detergents, fertilizers, glass, cement, plastics, ..., etc. are produced through chemical reactions.

USES OF COMMON SYNTHETIC MATERIALS

Steel, bricks, stones and cement are the basic building materials used in the construction of buildings. Sand (silicon dioxide or silica), clay (silicates), limestone or marble (calcium carbonate) and gypsum are the common raw materials which make cement. The construction industry mainly depends on the quality and availability of the cement in a country.

We use plastics, clothes made up of synthetic fibres, paints, glues, pesticides, rubber products like tyres and detergents in our daily life.

The computer industry is based on silicon. It is the second most common element in the earth's crust and found as silica or silicates. Silicon dioxide (silica) obtained from sand and rocks acts as raw material for the extraction of silicon. Silicon obtained from silicon dioxide is used for making 'silicon chip' which is used in computers.



Fig. 10.4 Computer

Common salt is used to produce caustic soda, washing soda, soda ash, hydrochloric acid, chlorine, ..., etc.

Caustic soda (sodium hydroxide) is used in the manufacture of soap, textile items and paper.

Washing soda (sodium carbonate) is used to make washing powder and glass.

Baking soda (sodium hydrogen carbonate) is used to produce bakery products, as constituent of medicines and many other useful things.

Chlorine is used along with other raw materials to prepare bleaches, PVC, ..., etc. It is also used in water treatment to kill harmful germs.

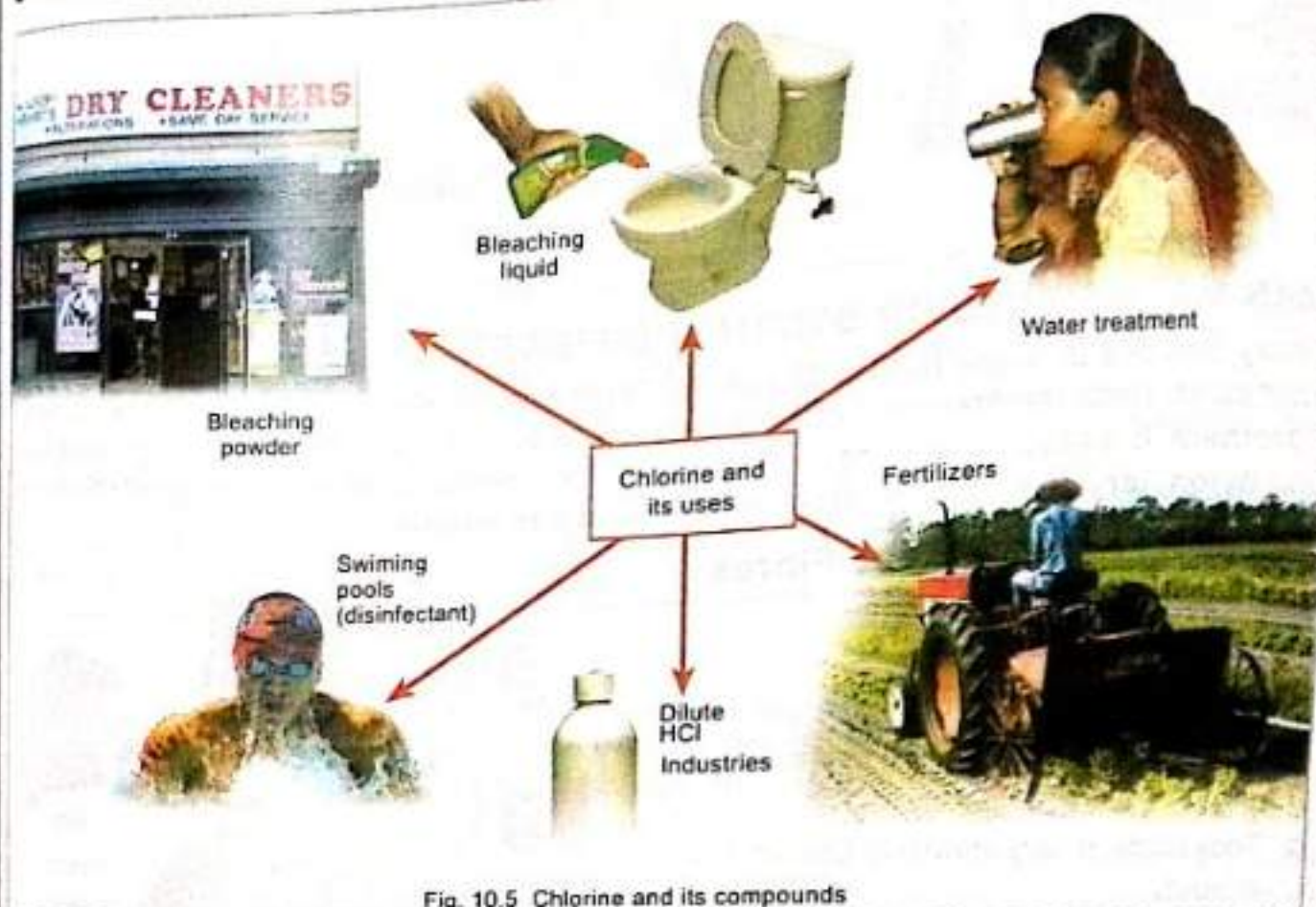


Fig. 10.5 Chlorine and its compounds

FIBRES

A fibre is a kind of thread which is strong and flexible enough to make clothes, nets, ropes, ..., etc. Fibres are of two types: **natural fibres** and **man-made fibres (synthetic fibres)**.

NATURAL FIBRES

Cotton, wool, linen and silk are the important natural fibres which are used for making fabrics (clothes). Cotton is obtained from cotton plants, wool is generally obtained from sheep and rabbits. Silk is obtained from cocoons of silk worm. Linen is made from the stalks of a plant called flax.

Good to know

Australia, China, and New Zealand are the largest wool manufacturers in the world. Australia contributes to nearly 25% of the world's wool production.



Fig. 10.6 Sources of natural fibres

MAN-MADE FIBRES OR SYNTHETIC FIBRES

Today, besides all these natural fibres, we have man-made, or synthetic fibres to make clothes. In 1940, the first synthetic fibre-**nylon**, was made by an American chemist **W. Carothers**. It is used for making a variety of textiles. Some of the common synthetic fibres are: **nylon, terylene, rayon, orlon, acrilon and cashmilon**.

Advantages of Synthetic Fibres

- ❑ They are strong.
- ❑ They are crease resistant.
- ❑ They are not attacked by moths and moulds.
- ❑ They are easy to wash and maintain.
- ❑ They dry-up more quickly.
- ❑ They come in very attractive colours and shapes.

Disadvantages of Synthetic Fibres

- ❑ They do not allow air to pass through them and hence are not good for summer.
- ❑ They do not absorb sweat so well as natural fibres do.
- ❑ They get damaged by high temperature when ironed.
- ❑ They catch fire more easily than cotton or wool.



Fig. 10.7 Man-made fibres

IDENTIFICATION OF VARIOUS TYPES OF FIBRES

We can distinguish between the various types of fibres by the **burning test**. For example, we can distinguish between the fibres of cotton, wool, silk, rayon, nylon, terylene and acrilon by burning a small piece of each of these fibres. Table 10.1 shows the results of burning of these fibres.

Table 10.1. Result of burning test of different fibres.

Fibre	Result of burning
Cotton	Burns vigorously with a characteristic smell of burning paper. No beads are produced.
Wool and Silk are produced.	Burns slowly with a smell of burning feathers or hairs. No beads
Rayon	Burns readily with a smell of burning paper.
Nylon	Burns slowly, fabric shrinks and forms a bead.
Terylene	Burns slowly, forms a bead.
Acrilon	Shrinks from flame, forms a black bead with a sooty flame.

ACTIVITY TIME! To conduct burning test for the identification of different fibers.

Suspend small pieces of cotton, wool, silk, nylon, rayon and acrilon from some support. Bring a burning match stick to each one of them at their loose ends. Allow them to burn for sometime and make observations. Draw your inferences about the nature of fibres on the basis of information given in Table 10.1.

PLASTICS

Plastics are man-made materials. They can be given any shape when they are warm. The twentieth century may be known as the **Plastic Age** just as the earlier periods are now called the Stone Age, the Bronze Age, the Iron Age, the Steel Age and so on. To a great extent, plastics are taking the place of wood, glass, cloth, metal, paper, stone etc. We have toys and chairs made of plastic instead of wood. Plenty of bottles and rain coats are now made of plastics. Tooth brushes, hair brushes, combs, ropes, ..., etc. are also made of plastics. We buy our eatables and many other things in plastic bags or wrappings. We play plastic records



Fig. 10.8 Goods made of plastic

on our record players. Thus, plastic materials are all around us. They are clean, bright, cheap, light and practically useful. Common plastics include polythene, PVC, polystyrene,

bakelite, perspex and celluloid.

Advantages of Using Plastics

- They are cheap, light and available in different colours.
- They are strong and resistant to corrosion.
- They can be moulded to any shape when hot.
- They are sensitive towards heat and melt quickly on heating.
- They are bad conductors of heat and electricity.
- They may be transparent, translucent or opaque.

Types of Plastics

There are, two types of plastics.

1. Thermoplastics.
2. Thermosetting plastics.

1. Thermoplastics

A plastic substance which can be melted repeatedly by heating and can be moulded again and again into different shapes is called a **thermoplastic polymer**.

Polythene is the most common example of thermoplastics.

2. Thermosetting Plastics

A plastic substance which does not soften much on heating and can be moulded only once is called a **thermosetting plastic**. Thus, softening and moulding are irreversible. Bakelite is a thermosetting plastic.

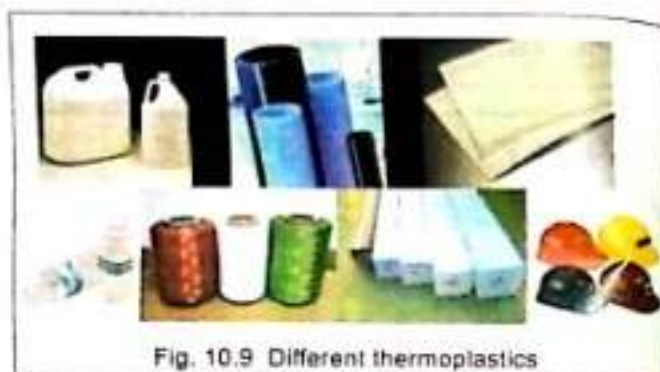


Fig. 10.9 Different thermoplastics



Fig. 10.10 Plugs and switches are made up of bakelite.

ACTIVITY TIME! To identify different plastics.

List ten substances made of plastics which you use in your daily life. Classify them as thermoplastics and thermosetting plastics.

Uses of Plastics

Some of the large number of uses of plastics are listed as under:

- They are used as insulating covering for electrical wiring.

- They are rolled between rollers to produce PVC sheets.
- They are used for making hand bags, rain coats and floor covering materials and covering for suitcases.
- They are used to cover motor car seats and furnitures.
- They are used for making gramophone records and refrigerator linings.



Fig. 10.11 Plastic insulation on wires

GLASS

Glass is of immense use in our daily life. It is used in cars, buses, houses, factories etc. It is used for making bulbs, bottles, tubes, mirrors, television screens, furniture, decorative pieces etc. Science laboratory instruments such as test tubes, beakers, burettes, flasks, thermometers, condensers etc. are made of glass because it can stand heat and is not affected by acids and alkalis. Glass is used for making lenses, which are used in spectacles, binoculars, microscopes, telescopes and cameras.



Fig. 10.12 Uses of glass

Though glass looks like a solid, yet, in a true sense, it is a super cooled liquid. It is non-crystalline, or an amorphous substance. Glass does not have any definite composition. The properties, quality and appearance of glass largely depends on the purity of the materials used.

The raw materials required for the manufacture of ordinary glass are:

- Sodium carbonate (soda ash) Na_2CO_3
- Calcium carbonate (limestone) CaCO_3
- Silica (sand) SiO_2

These materials are mixed and heated at 4000°C to produce glass.

ACTIVITY TIME! To prepare glass in laboratory.

In a big crucible, take a mixture of sand (silica), sodium carbonate and lime stone. Heat this mixture very strongly until a liquid mixture is obtained. Solidify this liquid. What do you get? You will find a clear and hard solid substance. This is glass.

Types of Glass

There are different types of glass which are used for different purposes. Some of the important types of glass are: soda glass, pyrex glass, optical glass, ground glass, glass wool and photochromic glass.

Coloured Glass

Coloured glass is prepared by the addition of small metallic oxides to the hot molten mixture of sand, sodium carbonate and lime stone. The choice of the metal oxide to be added depends on the colour to be imparted. Different metallic oxides give different colours to glass. Some of the metallic oxides and the colours they give to glass are given in Table 10.2

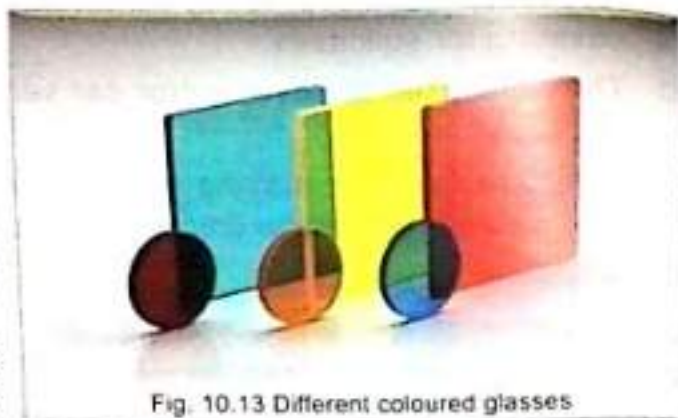


Fig. 10.13 Different coloured glasses

Table 10.2. Oxides that impart colour colours to glass

S. No.	Substance added	Colour imparted to glass
1.	Iron (III) oxide	Yellow
2.	Cobalt oxide	Blue
3.	Chromium (III) oxide	Green
4.	Selenium oxide	Red
5.	Manganese oxide	Purple or Violet

Coloured glass is used for making sun glasses, signals for automobiles, trains and aeroplanes and for decorative purposes.

SOAPS

Soap is used in homes and laundries for washing purposes. In addition to its use in homes and laundries, large quantity of soap is used in textile industries.

Good to know

Sometimes the leaves and fruits of some plants are soaked in water and used for washing clothes. The leaves and berries produce saponins, (chemical compounds which produce soapy lather). The saponins were probably the first detergent used by man.

A soap is defined as the sodium salt of a fatty acid which has cleansing properties in water. The main raw materials required for the manufacture of ordinary soap are:

- Animal fats or vegetable oils
- Sodium hydroxide.

Saponification

Soap is made by heating animal fat, or vegetable oils with concentrated sodium hydroxide solution. The fat, or oils react with NaOH to form soap and glycerol.



The process of making soap by the hydrolysis of fats and oils with alkalis is called saponification.

ACTIVITY TIME! To prepare soap in the laboratory or at home.

Take 20 ml of any vegetable oil in a beaker. In another beaker, dissolve about 10 g of NaOH in 40 ml of water. This solution is called **LYE**. Mix lye into the oil while stirring constantly. Now allow the mixture to boil and keep on stirring till a thick paste is produced.

Add small quantities of NaCl and Na_2CO_3 into the thick paste while stirring. Pour this paste into a mould of any shape. Allow it to stand overnight for solidification. Your soap is ready.

Cleaning action of soap

The soap molecule has a head that is attracted to water (i.e., it is hydrophilic) and a tail that is repelled by water (i.e., it is hydrophobic). The tail is attracted to grease, which is the main substance that holds dirt onto the cloths and skin. When soap is mixed with water, the tails attach themselves to grease particles and lift them away from the cloth or skin surface Fig. (10. 14).

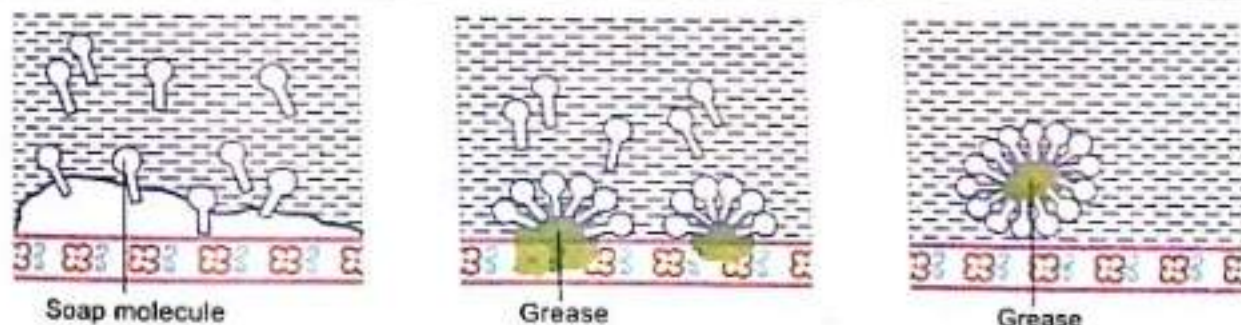


Fig. 10.14 The action of soap

Action of soap in hard water

Potassium hydroxide (KOH) is employed in place of sodium hydroxide (NaOH) to manufacture liquid soaps and shaving creams. The resulting potassium soaps are softer and produce a thick fine lather. Most soaps contain a number of additional materials such as perfumes, dyes and deodorants. Such type of soaps are used by us for cleaning our faces and bodies. Ordinary soap is sodium stearate ($\text{C}_{17}\text{H}_{35}\text{COONa}$) and it is water soluble. Hard water contains calcium and magnesium ions so when soap is added to hard water for washing

clothes, the calcium and magnesium of hard water reacts with sodium stearate soap to form insoluble white precipitate of calcium stearate and magnesium stearate. This is called SCUM. This scum clings to the pores of the clothes being washed and chokes them. As a result of this, the clothes are not cleaned properly. Hard water scum also causes blockage of pipes. Scum formation also causes wastage of soap.

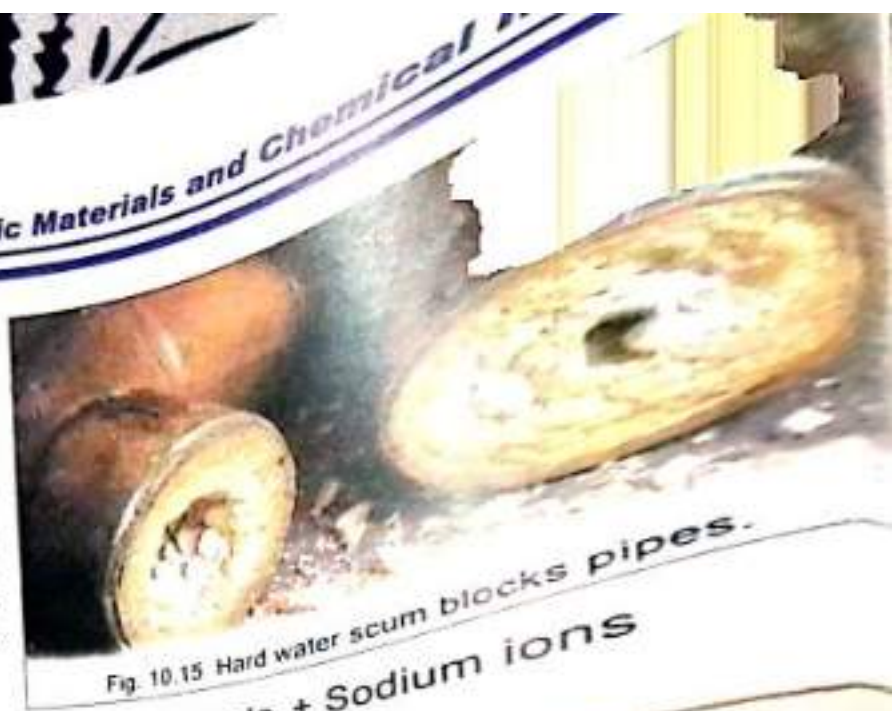


Fig. 10.15 Hard water scum blocks pipes.

Sodium stearate + Calcium ions
(Soap) (Hard water)

→ Calcium stearate + Sodium ions
(scum)

Good to know

One of the methods to remove hardness of water is to add sodium carbonate to water. It reacts to form insoluble calcium and magnesium carbonates. These settle down in water as precipitates and can be removed.

ACTIVITY TIME! To observe action of soap in hard water.

Take some tap water, well water and river water in three separate test tubes.

Add a few drops of soap solution in each test tube. Shake the test tubes vigorously. What do you observe? You will find that soap produces good lather with tap water. River, or well water does not produce much lather. What do you learn from this activity? This activity shows that hard water (river or well water) does not easily form lather with soap whereas soft water (tap water) easily produces lathers with soap.

Advantages of soap

- They are biodegradable.
- They are excellent cleansing agents.
- They are relatively non-toxic.
- Soaps do not pollute water reservoirs.
- They do not cause death and destruction of marine life.

Disadvantages of soap

- They are not suitable for washing in hard water.
- A large quantity of oil is consumed in their preparation.
- They have relatively weak cleansing action.

- They are less soluble in water than detergents.
- Continuous use of soaps makes our skin rough and dry.

DETERGENTS

Detergents are man-made chemicals obtained from petroleum hydrocarbons.

Sodium lauryl sulphate ($C_{12}H_{25}OSO_3Na$) is an example of synthetic detergent. Like soap, detergents are also made up of two-headed molecules. In sodium lauryl sulphate, $C_{12}H_{25}$ is the hydrophobic part, and $-OSO_3Na$ is the hydrophilic part. It is more soluble in water than soap. Detergents do not form any insoluble scum with calcium or magnesium ions and therefore, can be used even with hard water. They are also called **soapless soaps**.



Fig. 10.16 Different types of detergents

Advantages of Detergents

- They can be used even with hard water for washing clothes.
- They help us to save vegetable oils for human consumption.
- They have stronger cleansing action than soaps.
- They are more water soluble than soaps.

Disadvantages of Detergents

- They are not biodegradable. It means that they are not decomposed by micro-organisms.
- They cause water pollution problem.

Differences between soap and detergents

The main differences between soaps and detergents are given in Table 10.3.

Table 10.3. Differences between soaps and detergents

S. No.	Soaps	Detergents
1.	They are the sodium salts of fatty acids (vegetable oils).	They are the sodium salts of petroleum hydrocarbons.
2.	They are not suitable for washing in hard water.	They can be used for washing in hard water.
3.	They are prepared from animal fats or vegetable oils.	They are prepared from the petroleum hydrocarbons.
4.	They are biodegradable.	They are not biodegradable.
5.	They have a relatively weak cleansing action.	They have a strong cleansing action.

ACTIVITY TIME! To observe action of soap and detergent in hard water.

Take some hard water in two different test tubes. Add a few drops of soap solution into one and a few drops of detergent solution into the other test tube.

Shake vigorously. What do you observe? You will find that the soap solution does not produce good lather whereas the detergent solution does. Use the contents of the two test tubes separately to wash a piece of cloth. Which of the two works better? Why?

MANURES AND FERTILIZERS

Mineral nutrients of Plants

Just as we need vitamins, minerals, proteins etc. for our healthy growth, in the same way plants also need certain elements in the form of inorganic minerals for their growth. The most important elements required for plant growth are nitrogen, phosphorus and potassium which are known as **primary nutrients**. Next to the primary nutrients are the **secondary nutrients**. They are calcium, magnesium, iron and sulphur. Certain other elements like zinc, boron, copper etc. are needed in small quantities by plants. These are called **micro nutrients**. The nutrient elements which are essential for plant growth are given in Table 10.4.

Table 10.4. Elements essential for plant growth

	Obtained from Soil, Manures and Fertilizers		
Obtained from air and water	Primary nutrients	Secondary nutrients	Micro-nutrients
Carbon	Nitrogen	Calcium	Zinc
Hydrogen	Phosphorus	Magnesium	Manganese
Oxygen	Potassium	Iron	Copper
		Sulphur	Cobalt

Most plants absorb water and mineral nutrients from the soil and carbon dioxide from the air to make their food. However, when crops are grown year after year on the same piece of land, they draw considerable amount of valuable nutrients from the soil. Unless these valuable nutrients are readded into the soil, the growth of plants becomes poor and the quality and quantity of food grains decrease. Thus, the deficiency of necessary nutrients

in the soil is overcome by the addition of manures and fertilizers in it. (fig. 10.17).

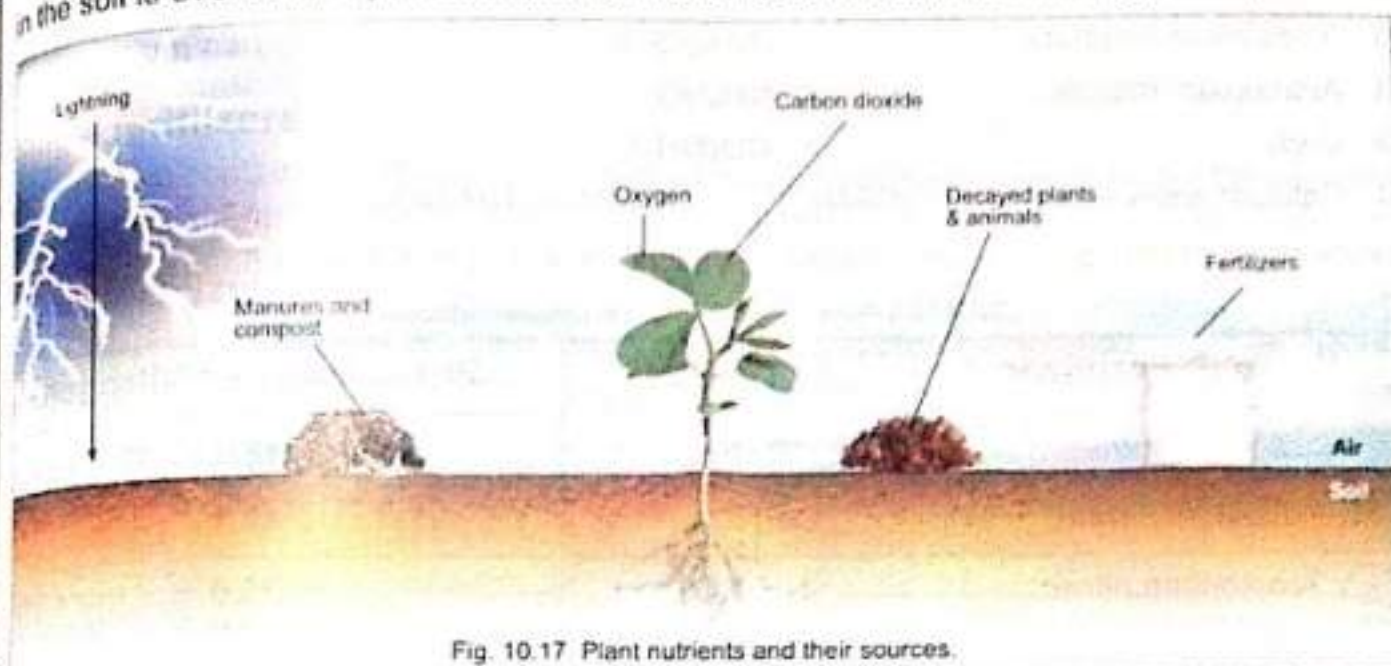


Fig. 10.17 Plant nutrients and their sources.

Manure

Manure is a natural substance obtained by the decomposition of animal wastes and plant residues. Manure supplies essential elements and humus to the soil and makes it more fertile. These manures are also called **organic fertilizers**. In most cases, the nutrients present in the soil are insufficient for plants, therefore, large amount of manure is added to overcome the deficiency of nutrients.

Fertilizers

A fertilizer is a man-made water soluble inorganic salt that contains one or more essential plant nutrients in proper proportions. Addition of fertilizers enriches the soil with nutrients and makes it more fertile. Fertilizers are also called **inorganic** or **artificial fertilizers**.

Types of fertilizers

There are three main types of chemical fertilizers depending on the primary nutrients they contain.

1. Nitrogen fertilizers

Nitrogen is the most important element for plant growth. The growth and sustenance of life of both animals and plants depend on proteins, and nitrogen is an important component of proteins. Deficiency of nitrogen in the soil, thus, causes reduction in yield. It also causes decolourization of leaves.

The basic raw material used to make nitrogenous fertilizers is ammonia (NH_3) gas. Ammonia is prepared by reacting nitrogen and hydrogen in a manufacturing process called the **Haber's process**.

Some of the important nitrogen fertilizers are:

- Ammonium sulphate: $(\text{NH}_4)_2\text{SO}_4$
- Ammonium nitrate: NH_4NO_3
- Urea: $\text{CO}(\text{NH}_2)_2$
- Calcium ammonium nitrate (CAN): $\text{Ca}(\text{NO}_3)_2\text{NH}_4\text{NO}_3$

Percentage of nitrogen in a few nitrogen fertilizers is given in Table 10.5.

Table 10.5 Percentage of nitrogen in nitrogen fertilizers

Name of Fertilizer	Formula	Percentage of Nitrogen
Sodium nitrate	NaNO_3	16.1
Calcium nitrate	$\text{Ca}(\text{NO}_3)_2$	17.1
Ammonium nitrate	NH_4NO_3	35.0
Ammonium sulphate	$(\text{NH}_4)_2\text{SO}_4$	21.2
Urea	$\text{CO}(\text{NH}_2)_2$	46.6

2. Phosphorus fertilizers

Phosphorus is an essential element in the structure of plants. It is also necessary for cell division. It is also important for root development. Phosphorus fertilizers are mostly available in the form of inorganic phosphates. Phosphates increase the sugar content in the beet root and the starch content in corn and potatoes and the yield of food grains in general. They quicken the plant growth and improve the quality of fibres. They help plants to resist diseases effectively.

Some of the important phosphorus fertilizers are:

- Ammonium phosphate $(\text{NH}_4)_3\text{PO}_4$
- Super-phosphate $\text{Ca}(\text{H}_2\text{PO}_4)_2$
- Triple super phosphate $3\text{Ca}(\text{H}_2\text{PO}_4)_2$

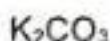
3. Potassium fertilizers

Potassium is also essential for the growth of plants. It is used by the plants mainly in the early stages of growth. It also assists in the formation of sugar, starch, protein, fat and other substances in plants. It makes the plants stronger and disease-resistant.

Some of the important potassium fertilizers are:

- Potassium chloride KCl
- Potassium sulphate K_2SO_4

- Potassium nitrate
- Potassium carbonate



Single fertilizers

The fertilizers containing only one primary plant nutrient (nitrogen, phosphorus, or potassium) are called single fertilizers. Sodium nitrate and ammonium sulphate are single fertilizers.

Mixed fertilizers

The fertilizers containing more than one primary plant nutrients are called mixed fertilizers. Ammophos and potassium nitrate are mixed fertilizers.

Complete fertilizers

Fertilizers of the NPK-type are known as complete fertilizers, because they supply all the three primary plant nutrients i.e. nitrogen, phosphorus and potassium.

Good to know

Excessive use of fertilizers causes soil water contamination. The water containing dissolved fertilizers reaches fresh water bodies such as lakes or ponds and causes unwanted growth of plants. It is called eutrophication.

CEMENT

In 1824, Joseph Aspdin a mason of Leeds, England, found that a strongly heated mixture of limestone and clay, when mixed with a small amount of water, sets in the form of a hard stone-like substance in a few hours. The mixture of limestone,



Fig. 10.18 Joseph Aspdin



Fig. 10.19 Portland stone

silica, iron oxide and alumina is called portland cement, because it forms stone-like masses on setting that resembles a portland rock- a famous building stone of England. The average composition of portland cement is given below:

CaO	62%	Fe ₂ O ₃	2.5%
SiO ₂	22%	SO ₃	1.5%
Al ₂ O ₃	7.5%	Na ₂ O	1.0%
MgO	2.5%	K ₂ O	1.0%

Cement is a dirty greenish, heavy and fine powder. Cement is manufactured by two processes: a wet process and a dry process.

Uses of Cement

Cement is one of the most important building materials and is employed in the construction of buildings, roads, dams, bridges etc. For this purpose, it is used in the form of a paste with sand and water.



Fig. 10.20 Uses of cement

Amazing facts!

Phosphorus is used in the construction of match boxes and fireworks industries. It is an important ingredient of many explosives.

Let's work in team!

Try making your own organic fertilizers by collecting dead leaves, grass clippings, tea leaves, vegetables and fruit peels and putting them in a heap. Turn and toss the compost heap regularly to aerate it. The compost heap should be kept moist but not too wet.



Teacher's corner

Conduct a class presentation in which inform students about the manufacturing processes of glass and cement.



KEY POINTS

Here is a list of key points to remember:

1. Cotton, wool, linen and silk are the naturally-occurring fibres used for making clothes.
2. Rayon, nylon, terylene, orlon etc. are the man-made, or synthetic fibres.
3. Clothes made of synthetic fibres are fine, light, durable, wrinkle resistant, easy to wash and dry and insects-repellent.
4. Synthetic clothes are unsuitable for summer because they do not allow air to pass through them.
5. Natural and synthetic fibres can be distinguished from one another by burning test.
6. A plastic material may be a thermoplastic or a thermosetting plastic.

- 🐼 Polythene, PVC, polystyrene, bakelite, perspex and celluloid are the commonly used plastics.
- 🐼 Glass is a supercooled liquid which is obtained by heating sand, sodium carbonate and limestone at a temperature of about 1400 °C.
- 🐼 Soda lime, hard glass, pyrex glass, flint and ground glass are some of the types of glass.
- 🐼 Coloured glass is made by the addition of small amount of metallic oxides to the hot molten mixture of glass.
- 🐼 Soaps and detergents are used as cleansing agents.
- 🐼 Soap is prepared by heating vegetable oils with caustic soda.
- 🐼 Soaps do not give good lather in hard water due to the formation of insoluble scum.
- 🐼 Detergents are synthetic cleansing agents made from hydrocarbons. Detergents work equally well with hard as well as soft water.
- 🐼 Nitrogen, phosphorus and potassium are the primary plant nutrients, whereas calcium, magnesium and iron are the secondary plant nutrients.
- 🐼 These nutrients are supplied to plants in the form of fertilizers.

KEY WORDS

- Ornaments:** decorative things.
- Silk:** natural fibre which is obtained from a worm.
- Bronze Age:** a period of time when Bronze was widely used in making things.
- Iron Age:** a period of time in which Iron was widely used in making objects.
- Lather:** a frothy white mass produced by soap.
- Gypsum:** common name of calcium sulphate.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Give five examples of man-made materials and natural materials each.
2. Name two types of fibres. Give two examples of each type.
3. What are the advantages of synthetic fibres?
4. How will you distinguish between cotton, wool, rayon and nylon?
5. What is plastic? Give five examples of plastics.
6. List four important properties of plastic.

7. What are thermoplastics and thermosetting plastics? Give two examples of each.
8. What is glass?
9. How do we obtain coloured glasses?
10. Name two materials commonly used as cleansing agents.
11. How does soap remove dirt?
12. What are soap and detergents? How are they made?
13. Why do we prefer to use detergents instead of soap, if the water is hard?
14. What is manure and how is it produced?
15. Name two nitrogenous and two phosphorous fertilizers.
16. Define cement and write its uses.

B. Fill in the following blanks:

1. A plastic material may be a or a
2. clothes are unsuitable for summer.
3. are used as cleansing agents.
4. and are added to the soil to make it more fertile.
5. Cement is manufactured either by a or a process.

C. Decide whether the following statements are TRUE/FALSE:

1. Cotton is a naturally-occurring fibre.
2. Glass is a homogeneous mixture.
3. Plastic is prepared by heating vegetable oil.
4. Soap is prepared by heating sodium hydroxide and vegetable oil or fat together.
5. Fertilizers are insoluble in water.
6. Phosphorus is added to the soil in the form of super phosphate.
7. Cement is dirty greenish, heavy and fine powder.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

8. Cement is prepared by mixing stones, clay and potassium.
9. Computer chips can be made from silica.
10. Coloured glass is prepared by the addition of small amount of acids to the hot molten mixture of glass.

D. Give one word answer of the following questions:

1. Which is the second most common element in the earth's crust?
2. What is the chemical formula for caustic soda?
3. Write down the word equation of the process of soap formation?
4. What is the chemical formula of urea?
5. Which gas is used to prepare ammonium nitrate?

E. Choose the most appropriate answer for the following statements:

1. Which of these is not a phosphate fertilizer?
a. ammonium phosphate b. triple super phosphate
c. super phosphate d. phosphorus pentachloride
2. The chemical name of lime stone is:
a. potassium carbonate b. sodium carbonate
c. calcium carbonate d. barium carbonate
3. Raw material used for the production of portland cement along with lime stone and clay is:
a. calcium b. iron oxide
c. potassium c. sodium
4. The compound used along with vegetable oil for the preparation of soap is:
a. sodium hydrogen carbonate b. sodium sulphate
c. sodium hydroxide d. super phosphate
5. For the production of detergents, raw material is obtained from:
a. rocks b. air
c. naphtha d. natural gas
6. Which is not a nitrogen fertilizer?
a. ammonium sulphate b. calcium hydrogen phosphate
c. ammonium phosphate d. urea

7. The element needed for the growth of plant along with nitrogen and potassium is:
- a. sodium
 - b. phosphorus
 - c. uranium
 - d. chlorine
8. The chemical formula of urea is:
- a. $(\text{NH}_4)_2\text{SO}_4$
 - b. NH_4NO_3
 - c. $\text{CO}(\text{NH}_2)_2$
 - d. $\text{Ca}(\text{NO}_3)_2$
9. Which fertilizer is used to compensate for the deficiency of phosphorus in plants?
- a. super phosphate
 - b. chlorine gas
 - c. sodium phosphate
 - d. calcium phosphate
10. Apart from potassium chloride, which compound is used as a source of potassium?
- a. potassium hydroxide
 - b. potassium carbonate
 - c. potassium nitrate
 - d. potassium dichromate

Homework Assignment



Search and study about the animals which are hunted for raw materials and are facing the danger of extinction. Make a list of such animals and the materials obtained from them.

FUN WITH SCIENCE

Classify the following substances of daily use as natural and synthetic substances: Iron, limestone, rayon, soap, glass, mercury, paper, anacin, kerosene, urea, D.D.T, cement, wood.

Force and Pressure

Learning Objectives

At the end of this unit, students should be able to:

- understand and define thrust.
- understand and define pressure and its units.
- list practical applications of thrust and pressure.
- understand, define and explain atmospheric pressure, its measurement and unit.
- understand and describe that the pressure in a liquid varies with depth.
- understand and demonstrate that liquids exert pressure in all directions.
- understand and define buoyancy and list factors on which the buoyant forces depend.
- understand, state and explain Archimedes' principle.

INTRODUCTION TO FORCE

We often use the word 'force' in everyday life. You have already learnt that a force is a push or a pull which produces acceleration in a body. Whenever we push or pull something, we say that we have applied or exerted a force. By applying force on an object, we can make it move faster or slower. We can also stop a moving object or set a stationary object in motion by applying force. Balanced forces on a body may change its volume or in case of solids may change its length or its shape.



Force can make things start moving and also change their speed.



Forces can change the direction of moving objects.



Force can stop a moving object.

Fig. 11.1 Features of force

THRUST

Hold a book on the palm of your hand as shown in Fig. 11.2. You know that the weight of an object is the force with which the object is pulled vertically downwards towards the earth. A force equal to the weight of the book acts downwards on your palm in a direction perpendicular to the palm.

When you want to close a door, you apply

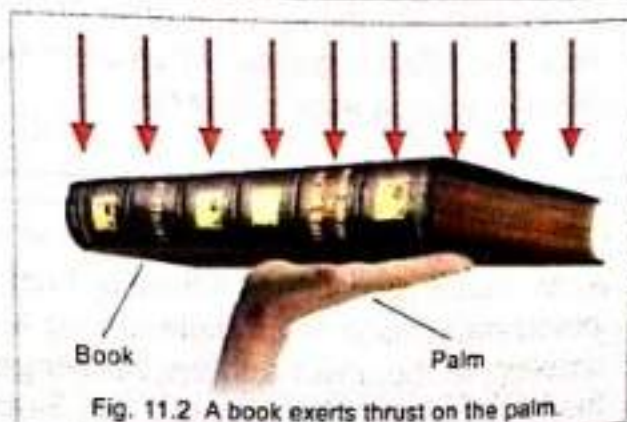


Fig. 11.2 A book exerts thrust on the palm.

force in a direction perpendicular to the door (Fig. 11.3). When you fix a paper on a notice board of your school, you use drawing pins and press them with your thumb. Thus, you apply a force perpendicular to the surface of the board towards the board.

In all the above cases, the force acts perpendicular to and into the surface. A force acting perpendicular to and into a surface is called **thrust**. The S.I. Unit of thrust is **Newton (N)**.

ACTIVITY TIME! To observe thrust in everyday life.

Press both ends of a drawing pin on your finger. What do you observe? You will feel that pressing the sharp end is painful while the flat end is not. On pressing hard, a mark is left on the skin by the sharp end. It can be explained by saying that pressure exerted by the sharp end of fine area is much more than that by the flat end of large area and it increases by applying greater force. Therefore, we can say that the pressure increases with the increase of thrust or decrease in area.



Fig. 11.3 The man applies thrust to close the door.

ACTIVITY TIME!

Take two nails of the same size, one with pointed end and the other with flat end. Hammer the head of each nail into a wooden block with the same force (Fig. 11.4). What difference will you find in both the cases? Which nail pierces the wood more easily? You will notice that the nail with pointed end will pierce the wood more easily because the force applied on it is acting on a smaller area. So, it is clear that the effect of a thrust depends on the area on which it acts. The effect is greater when the area over which the force acts is smaller.

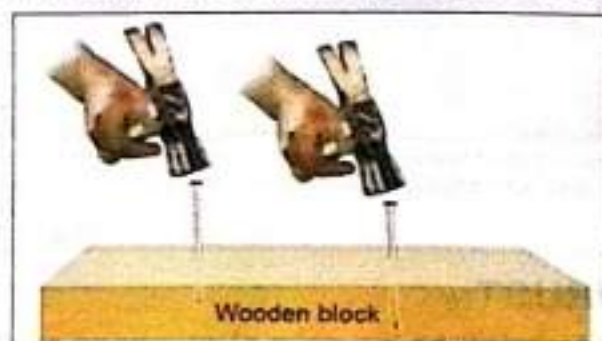


Fig. 11.4 A pointed nail pierces more easily than a flat nail.

Good to know

A car usually crumples in a front or back collision. The front and back parts of a car are intentionally made to crumple during a collision to reduce the impact of the forces of collision on the driver and the passengers. These parts are called **crumple zones** and they are the safety features of a car. Search internet for 'crumple zones' to find out more.

The effect of thrust depends upon the following two factors:

- The magnitude of the force.
- The area on which the force is acting.

PRESSURE

We can define pressure as the thrust (force) acting per unit area. It can be expressed through following formula:

$$\text{Pressure} = \frac{\text{Thrust (force)}}{\text{Area}}$$

From the above formula, we can conclude that pressure increases with the increase in thrust and decreases with the increase in the area of its application.

Unit of Pressure

The S.I. unit of pressure is Newton per square metre (N/m^2). It is also known as Pascal (symbol: Pa); the name has been given to honour the French scientist Blaise Pascal who contributed a lot in the field of vacuum and pressure.



Fig. 11.5 Blaise Pascal

Numerical problems related to pressure

Example 1

A block weighing 50 N is placed on a wooden plank of 1 m x 0.5 m. Find the pressure exerted by the board on the ground.

Solution

Force or thrust = 50 N
 Area over which this force acts = 1 m x 0.5 m
 = 0.5 m^2

Formula: Pressure = $\frac{\text{Force or thrust}}{\text{Area}}$

By putting the values in the formula:

$$\begin{aligned} \text{Pressure} &= \frac{50 \text{ N}}{0.5 \text{ m}^2} \\ &= 100 \text{ N/m}^2 \end{aligned}$$

Example 2

A boy weighing 50 kg stands on an ice skate whose blade is 0.5 cm wide and 25 cm long. What pressure does he exert?

Solution

Mass of the boy

$$= m = 50 \text{ kg}$$

Force exerted by the boy on the skate = $w = mg$

$$= 50 \text{ kg} \times 9.8 \text{ m/s}^2$$

$$= 490 \text{ N}$$

Area over which this force acts

$$= 0.5 \text{ cm} \times 25 \text{ cm}$$

$$= 12.5 \text{ cm}^2$$

$$= 0.00125 \text{ m}^2$$

Formula:

$$\text{Pressure} = \frac{\text{Force or thrust}}{\text{Area}}$$

By putting the values in the formula

$$\begin{aligned} \text{Pressure} &= \frac{490 \text{ N}}{0.00125 \text{ m}^2} \\ &= 392,000 \text{ N/m}^2 \text{ or } 3.92 \times 10^5 \text{ Pa.} \end{aligned}$$

Practical applications of thrust and pressure

The pressure exerted by a body can be reduced by increasing its surface area. This principle is widely used in the following cases:

- ❑ The base of the dam is made wide to increase the strength of the dam, so that it can withstand the enormous pressure of the stored water which increases with the increase in the depth of water. In addition, due to the wide base of the dam, the pressure exerted by the dam structure on the earth is greatly reduced.
- ❑ The base of the walls of a building is made wider to reduce the pressure exerted by the building (Fig. 11.6).
- ❑ The tyres of buses and trucks have broad and double wheels, so that the pressure on the tyres is reduced and they do not burst (Fig. 11.7). The bigger the wheels, the lesser is the pressure on them and so they can carry greater weight.
- ❑ Heavy tractors can go through marshy land and muddy soil easily because their rear wheels have large surface area.



Fig. 11.6 The base of the wall is made wider to reduce the pressure of the building.



Fig. 11.7 Broad, double wheels reduce pressure on tyres of buses and trucks.

- Railway tracks are laid over wooden sleepers which are set over bits of broken stones to reduce the pressure on the ground.

Sometimes, the pressure of a body can be increased by decreasing the area over which it acts. This principle is widely used in the following cases:

- All cutting and piercing tools like saws, needles, knives, scissors, nails, nutcrackers, axes, pliers etc. have sharp points or blades, so that they can exert great pressure with comparatively small applied force (Fig. 11.9).



Fig. 11.8 Railway track

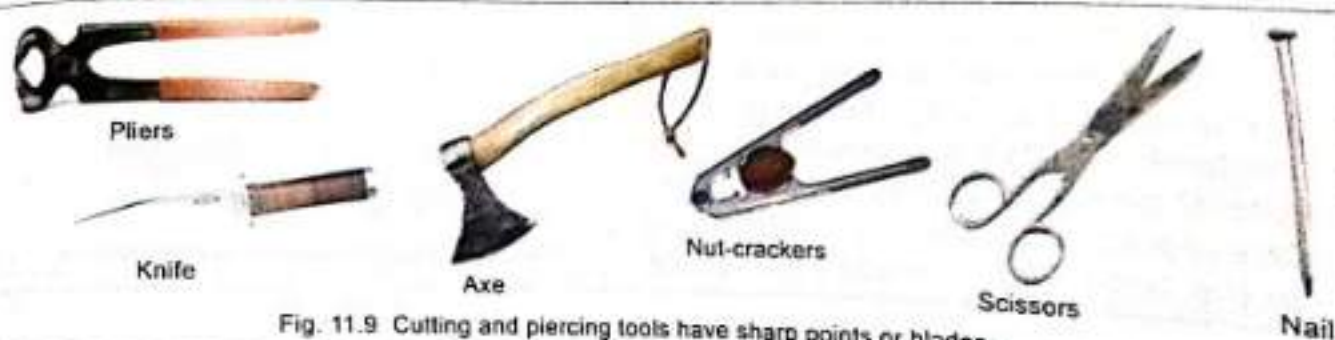


Fig. 11.9 Cutting and piercing tools have sharp points or blades.

Can you now explain why it is always easier to cut with a sharp knife than with a blunt one?

PRESSURE IN LIQUIDS

Unlike a solid, liquids do not have a definite shape of their own. They take the shape of the container in which they are contained and exert pressure not only at its base but also on its walls.

ACTIVITY TIME! To show that liquids exert pressure on the base of a vessel.

Take a wide glass tube open at both ends and tie a balloon at its lower end. Hold the tube vertically and pour some water into it. Observe what happens. Pour more water and again observe the balloon. You will notice that balloon keeps bulging downwards (Fig. 11.10). This activity shows that liquid exerts pressure on the base of a vessel in which they are contained.

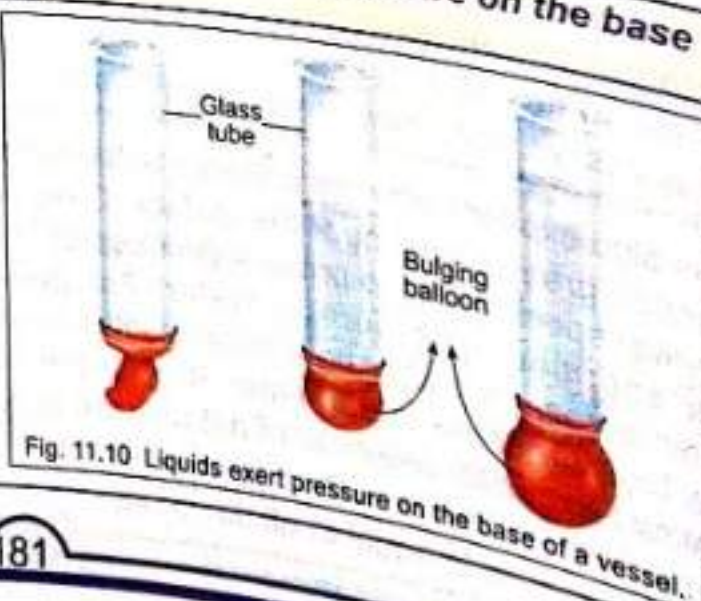


Fig. 11.10 Liquids exert pressure on the base of a vessel.

Liquids exert lateral pressure

You have seen that like solids, liquids also exert pressure. But unlike solids, liquids exert pressure not only at the bottom but also on the sides of the vessels in which they are contained.

ACTIVITY TIME! To show that liquids exert lateral pressure.

Take a tube having an opening on its side. Cover the opening with a balloon. Now pour some water in the tube. You will notice that the balloon bulges outward as shown in Fig. 11.11. Add more water and you will see that the balloon bulges further.

This activity shows that liquids exert pressure not only on the base of a container but also on the walls of the container. This side-way pressure is called lateral pressure. The existence of this lateral pressure is one of the differences in the behaviour of solids and liquids.

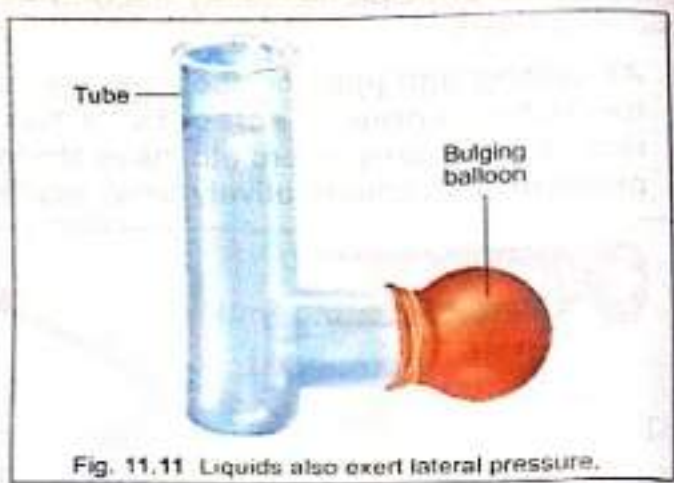


Fig. 11.11 Liquids also exert lateral pressure.

Pressure in a liquid increases with depth

ACTIVITY TIME! To show that pressure in a liquids increases with depth.

Take an empty tin container and make a few holes in it at different levels, as shown in Fig. 11.12. Plug the holes with plasticine. Fill the can completely with water and remove the plasticine. What do you observe? You will observe that the pressure with which water flows out increases according to the depth of the hole under the water surface (Fig. 11.12). This activity shows that pressure in a liquid increases with depth.



Fig. 11.12 The pressure in a liquid increases with depth.

This also explains why the pressure at the bottom of the ocean is much greater than near the surface. Deep-sea divers have to wear special suits to prevent their bodies being crushed by the enormous pressure of water. For the same reason, submarines are built of hard thick sheets of metal to withstand the high pressure under water. It is for this reason that the walls of the water reservoir of a dam have to be made thicker at the bottom. It is important to note that at a fixed depth, the liquid pressure is equal in all directions.



Fig. 11.13 Deep sea diver suit

Factor that affect liquid pressure

The pressure in a liquid at certain depth depends upon the following factors:

1. The height of the liquid column. The greater the height, the greater the pressure.
2. The density of the liquid. The greater the density, the greater the pressure.

ACTIVITY TIME! To show that at the same depth, the pressure of liquid is same in all the direction.

Take an empty tin and make several holes round the tin can. Make sure that all the holes are of the same size and at the same height. Plug the holes with plasticine and fill the tin with water. Remove the plasticine. What do you observe? You will find that water flows out of these holes with equal pressure (Fig. 11.14). This activity proves that at the same depth, the pressure in a liquid is equal in all directions.



Fig. 11.14 At the same depth, the pressure of liquid is the same in all directions.

Pascal's law and transmission of liquid pressure

According to this law, when pressure is applied to an enclosed fluid, it is transmitted equally in all the directions throughout the fluid. This is called Pascal's Law. Pascal's Law holds good for liquid as well as gases.

ACTIVITY TIME! To show transmission of pressure in liquids.

Take polythene container and make few holes in it. Fill the container with water and close its mouth with a cap. Press it hard with your hand. You will notice that water flows out from these holes in all directions (Fig. 11.15). You will also find that water comes out with equal pressure through all the holes.

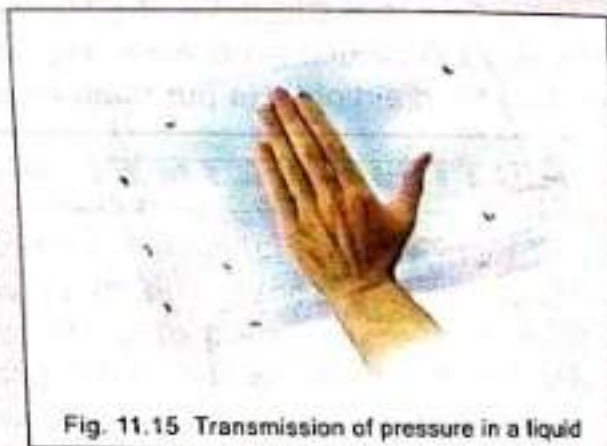


Fig. 11.15 Transmission of pressure in a liquid

Application of Pascal's Law

An important application of Pascal's law is in the construction and use of hydraulic press and hydraulic brakes.

Hydraulic press is used for obtaining large force for compressing cotton and jute bales and in the manufacture of cardboard and plywood. In oil mills, these machines are used for squeezing oil out of the seeds.

Pascal's principle is also put to use by automobile manufacturers for designing hydraulic brakes for cars, buses, trucks etc. (Fig. 11.16). When the driver wants to apply brakes, he pushes down the brake pedal. The brake oil transmits the pressure which pushes the brake shoe and lining against the rotating brake drum. This brings the vehicle to a halt. When the pressure on the brake pedal is released, the spring pulls back the shoe.

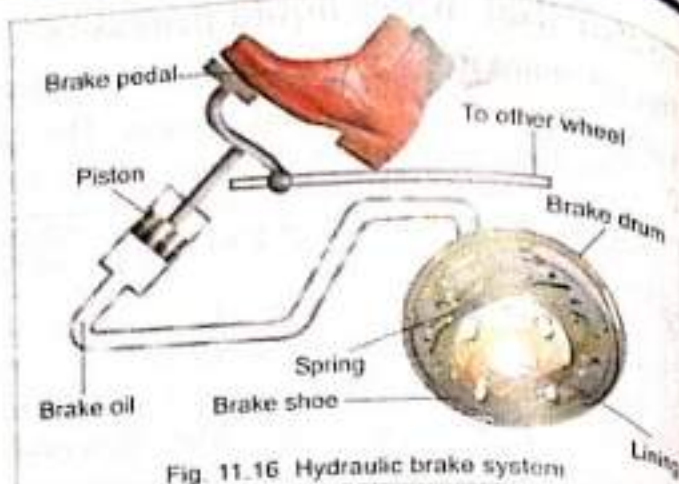


Fig. 11.16 Hydraulic brake system

Hydraulic freight elevators used in factories and other buildings and **hydraulic jacks** used in service garages also work on the principle of Pascal's Law.

ATMOSPHERIC PRESSURE

We all know that we live under a thick layer of air called the **atmosphere**. The earth's atmosphere extends to a height of about 480 kilometres. The air is denser near the earth's surface due to gravitational pull. It becomes thinner and thinner as we go up. Near the surface of the earth the density of air is about 1.29 kg/m^3 .

This pressure which is exerted by the atmospheric air is called **atmospheric pressure**.

In 1654, **Otto Von Guericke**, the Mayor of Magdeburg, Germany did a very spectacular experiment. He took two hemispheres which could be fitted airtight. He put them together and used a vacuum



Fig. 11.17 Otto Von Guericke

ACTIVITY TIME! To show that air exerts pressure.

Boil some water in a thin-walled tin can keeping its mouth open. The steam will drive out the air. Cork the can tightly. Remove it from the fire and cool the can by pouring cold water over it. The steam condenses into water leaving a partial vacuum in the can. What happens to the can? It is crushed by the pressure of the air outside as shown in Fig. 11.18.



Fig. 11.18 Tin gets crushed due to atmospheric pressure.

to pump to take all the air out. He then tried to pull them apart. The air pressure was so great that two teams of 16 horses pulling in opposite directions could not separate the two hemispheres (Fig. 11.19).

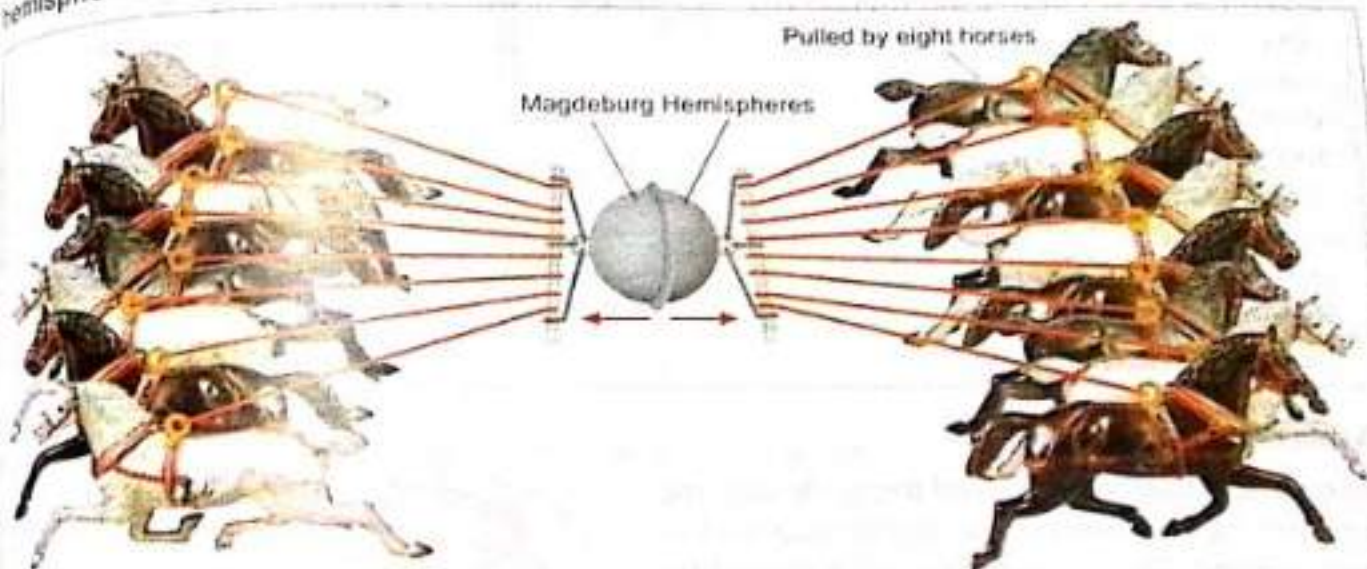


Fig. 11.19 The effect of atmospheric pressure was not overcome even by the efforts of 8 pairs of horses.

Measuring atmospheric pressure

Atmospheric pressure is measured with the help of a device called the barometer. It was invented by an Italian scientist E. Torricelli in 1643.

Types of Barometers

There are two types of barometers which are in use:

1. Mercury barometers
2. Aneroid barometers



Fig. 11.20 E. Torricelli

ACTIVITY! To construct a mercury barometer.

Take a 100 cm long, narrow bore, stout glass tube closed at one end and fill it completely with mercury. Tap the tube to ensure that there are no air bubbles inside. Now, close the top end of the tube with a finger (Fig. 11.21). Then invert this tube, so that its open end is inside a trough containing mercury. Now hold the tube in a vertical position and remove your finger. You will find that some mercury flows out of the tube into the trough leaving empty space at the top of the tube (Fig. 11.21). However, an appreciable amount of mercury remains standing in it. Measure the height of mercury in the tube. You will find that a mercury column of about 76 cm (0.76 m) stays in the tube.

At sea level, the level of mercury in the tube is found to stay at a height of 76 cm above the mercury level in the trough. At a height of about 100 m above sea level, the atmospheric pressure is less and the level of mercury falls to 73 cm. The pressure which can maintain 76 cm high column of mercury is said to be equal to one atmosphere. Note that 1 atmosphere = 1.01×10^5 Pa.

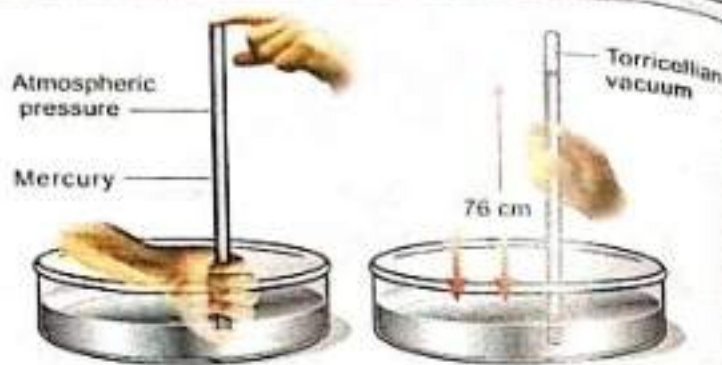


Fig. 11.21 Making a mercury barometer

Aneroid Barometer

Many of the barometers used today do not use mercury as it is heavy and expensive and is easily spilled. These days, aneroid barometers are commonly used because they contain no liquid. Thus, it is light, handy and quite convenient to be carried from one place to another.

It consists of a partially evacuated metal box (Fig. 11.22) which has a flexible lid held by a strong spring. Changes in the atmospheric pressure produce corresponding small changes in the shape of the lid. The small movement of the flexible lid is magnified by a system of levers which pulls a cord wound over a pulley. The other end of the cord is attached to one end of a spring whose second end is fixed. As the atmospheric pressure increases, the lid moves inwards, the pulley and hence the pointer turns clockwise. However, when the atmospheric pressure decreases, the pulley and hence the pointer turns anticlockwise. The pointer moves over a circular scale calibrated with a standard mercury barometer.

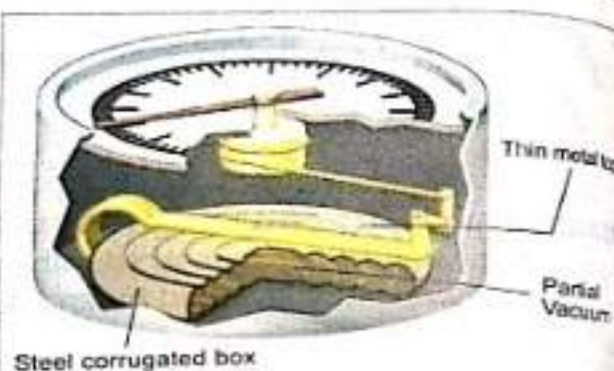


Fig. 11.22 An aneroid barometer

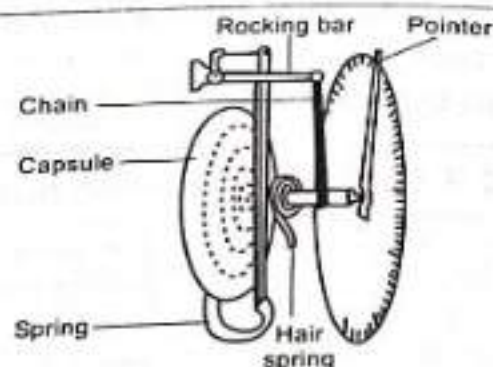


Fig. 11.23 Internal structure of aneroid barometer

Uses of barometers

- It is used in the laboratory to find atmospheric pressure.

- It is used in weather forecasting.
- Aneroid barometer can be used as an altimeter to measure the altitude.

Variations of atmospheric pressure

- The atmospheric pressure changes from place to place and from time to time due to changes in temperature and the quantity of water vapours in the air. These factors determine the density of air. The density of moist air is less than that of dry air. The density also decreases with an increase in temperature. Consequently, the atmospheric pressure also decreases.
- The atmospheric pressure at a place is due to the weight of the air above it. It is obvious that the pressure will decrease as you go higher up above the sea level. Therefore, on the mountains and hill tops, the pressure is less.
- Roughly speaking, the atmospheric pressure falls by one cm of mercury for every ten metres rise in altitude or height.

Weather condition and atmospheric pressure

Weather conditions at a place change from time to time and are very much governed by atmospheric pressure.

- High pressure is associated with fine weather. While low pressure indicates unsettled weather.
- The fall of pressure shows presence of more water vapours in the atmosphere which indicates that it is about to rain or snow.
- Increasing atmospheric pressure indicates a cloudless sky and dry weather.
- If the atmospheric pressure falls suddenly, it indicates the likelihood of a storm.

Good to know

Our body and the bodies of all other living organisms are made-up of cells which have fluids that exert pressure from within. This pressure exerted from the inside of the cell is equal to the atmospheric pressure. What would happen, if an organism is placed in a jar and the jar is evacuated? The unbalanced pressure from inside the cell would then cause it to burst and the organism would die. Nose bleeding is quite common amongst those who trek to high altitude. Can you give any reason for this?

Practical uses of air pressure

Air pressure is useful to us in several ways:

- It is used for inflating balloons and tyres etc.
- It is used for filling your fountain pen with ink.
- Doctors make use of air pressure in giving injection.
- We use air pressure while sipping cold drinks through a straw.

Standard atmospheric pressure

Sea level is taken as standard for expressing the atmospheric pressure. The atmospheric

pressure at sea level is considered as **standard pressure**. The value of standard atmospheric pressure is 76 cm of mercury or 0.76m of mercury. The value of standard atmospheric pressure in M.K.S. system is 101325 N/m^2 .

BUOYANCY

It is our common experience that objects lose some weight when immersed in water. In a bathing tub or while swimming you feel lighter. Similarly, when you push a piece of wood under water and release it, it soon rises up to the surface. While rowing a boat, the oars are found to be lighter inside the water. We also observe this when we draw water from a well or a tank. The bucket seems lighter as long as it remains immersed in water but suddenly feels heavier when it emerges above the water surface. While taking bath, as long as the mug you use to take out water from the bucket is under water, it feels much lighter than when it is raised. In all these cases, it is the upward pressure of water, termed as buoyancy or upthrust, that makes the body feel lighter. This can be shown by the following activity.

ACTIVITY TIME! To show buoyancy in water.

Tie a string to a rectangular metal block and suspend it from a spring balance. Record the weight of the metallic block. Now immerse the metallic block gradually inside water contained in a large beaker (Fig. 11.24). You will observe that the spring balance records a lower weight. Let us suppose the weight of the metallic block in air is 200 N and the weight in water is 150 N . Then the buoyant force acting on the metallic block is $200 - 150 = 50 \text{ N}$. This activity shows that object loses some weight when immersed in a liquid.

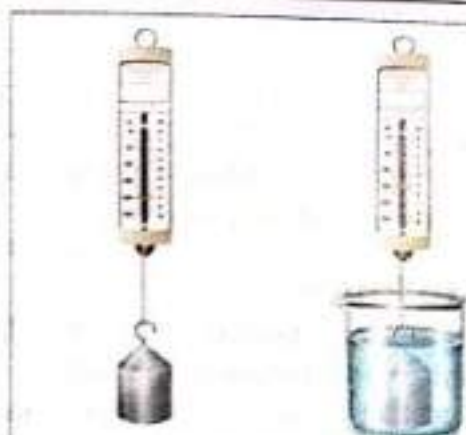


Fig. 11.24 Bodies immersed in water lose weight.

Why do substances lose weight in a liquid

When an object is immersed in a liquid, it is acted upon by two forces (Fig. 11.25). The earth's gravitational force pulls the object down while the liquid exerts an upward force on the body.

The upward force, experienced by a body when partly or completely immersed in a liquid is called the **buoyant force** and this phenomenon is called **buoyancy**. It is due

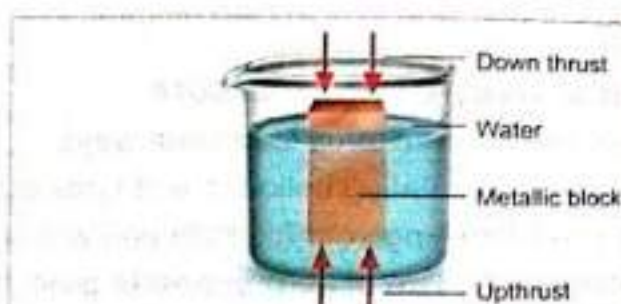


Fig. 11.25 Forces acting on a body when immersed in a liquid.

to this buoyant force that the weight of a body immersed in a liquid appears to be less than its actual weight. A body immersed in a gas also experiences buoyant force.

Factors on which the buoyant force depends

The buoyant force depends upon two factors.

1. The size or volume of the body immersed in a liquid. The larger the size, the greater the buoyant force.
2. The density of the liquid in which the body is immersed. The greater the density, the greater the buoyant force.

Good to know

Archimedes' Principle states that when a body is completely or partly immersed in a liquid, the body loses weight which is equal to the weight of the liquid displaced by the immersed part of the body. This principle is used to verify purity of substances.

PRINCIPLE OF FLOTATION

It is a very common experience that a cork released in water rises and floats on the surface, whereas a stone sinks to the bottom.

The buoyant force acts both on the cork and on the stone. This buoyant force acting upwards in each case is equal to the weight of the water displaced by each.

When we put any object in water we have the following three possibilities:

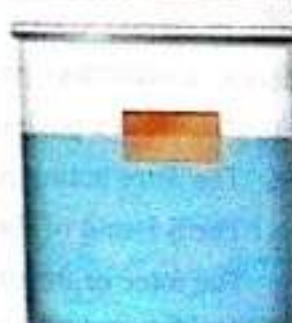
1. If the weight of the object is more than the buoyant force, then the body will sink, e.g. a stone. This is shown in Fig. 11.26 (a).
2. If the weight of the object is equal to the buoyant force, then the body floats while completely immersed in the liquid. In this case, the buoyant force must balance the weight of the body (Fig. 11.26 b).



(a) Body sinks.



(b) Body just floats completely immersed in the liquid.



(c) Body floats with a part above the liquid surface.

Fig. 11.26 Principle of flotation

3. If the weight of the body is less than the buoyant force, then the body floats on the surface of the liquid with only that part under the liquid surface which displaces liquid

equal to the weight of the body.

It is clear that a body will float in a liquid, if the weight of the liquid, displaced by its immersed portion, is equal to its own weight. This is called the **principle of flotation**.

Some applications of the principle of flotation

1. **Ships:** Ships are so designed that they are capable of displacing water equal to their own weight and that of all cargo and passengers. If an extra load is added, the ship sinks deeper, so that additional water is displaced equal to the weight of the load. Therefore, a ship floats on water.

2. **Submarines:** A submarine floats in water just as a ship does. The difference is that a submarine is provided with tanks. When a submarine has to dive, the tanks are filled with water so that the weight increases. To return to the surface again, water is forced out of the tank by means of pumps.

3. **Icebergs:** Large pieces of ice floating in sea water are called icebergs. The density of ice is a little less than the density of sea water. Therefore, an iceberg floats on sea water.

Amazing facts!

We can dive only upto the depth of 120 meters in water. The water pressure below this is enough to crush the human body.

Let's work in team!

Under the supervision of your teacher, construct a working model of a ship using the principle of buoyancy and flotation.

Teacher's corner

Conduct a class presentation in which inform students about the effect of low and high atmospheric pressure on living organisms.



KEY POINTS

Here is a list of key points to remember:

- 🔑 A force is a push or a pull.
- 🔑 The force acting perpendicular to a surface is called thrust.
- 🔑 The S.I. unit of thrust is Newton.
- 🔑 The force or thrust acting per unit area is called pressure. $\text{Pressure} = \text{Force or thrust} / \text{Area}$.
- 🔑 The S.I. unit of pressure is Newton per square metre (N/m^2).
- 🔑 The pressure exerted by a liquid increases with increasing depth of the liquid.
- 🔑 At a given depth, liquids exert equal pressure in all directions.
- 🔑 Liquids and gases exert pressure not only at the bottom but also on the side of the vessel in which they are contained.

- 🐼 Liquid tends to seek its own level.
- 🐼 Pascal's law states that the pressure in an enclosed fluid (liquid or gas) is transmitted equally in all the directions throughout the liquid.
- 🐼 Pascal's principle is put to use in hydraulic jacks, hydraulic brakes and hydraulic press.
- 🐼 The pressure exerted by air is called atmospheric pressure.
- 🐼 At sea level, atmospheric pressure is 76 cm or 0.76 m of mercury. In MKS units, its value is about 101325 N/m^2 .
- 🐼 The atmospheric pressure at a specific place is measured with a device called the barometer.
- 🐼 The pressure which can support 76 cm of mercury in a mercury barometer is called one atmosphere or 1 bar.
- 🐼 Atmospheric pressure varies from place to place and from time to time.
- 🐼 The upward force experienced by a body when partly or completely immersed in a liquid is called the buoyant force.
- 🐼 Buoyant force is equal to the weight of the liquid displaced by the immersed object.
- 🐼 Archimedes' principle states that when a body is partly or completely immersed in a fluid, it experiences buoyant force which is equal to the weight of the fluid displaced by it.
- 🐼 A body floats in a liquid if the weight of the liquid displaced by its immersed portion is equal to its own weight. This is called the principle of flotation.

KEY WORDS

Perpendicular:	at an angle of 90° to any surface
Buoyancy:	ability to keep something floating.
Blunt:	not having a sharp edge.
Vacuum:	a space entirely empty of matter.
Spectacular:	amazing/magnificent.
Exert:	to apply.
Plasticine:	a soft modeling material.
Vessel:	a hollow container/ A ship.
Bulge:	to swell up.
Hydraulic:	related to movement of liquids under pressure.
Jack:	a device for lifting heavy objects.

Archimedes: a famous Greek mathematician and physicist.

Hemisphere: half of a sphere.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Define force.
2. What do you mean by the term 'thrust'?
3. Define the term 'pressure'. What is the S.I unit of pressure?
4. How will you prove that liquid pressure increases with depth?
5. Describe a simple experiment to prove Pascal's law.
6. Name and state the principle on which the hydraulic press works.
7. State Archimedes' principle.
8. What is a barometer? What is its use?
9. State two advantages of an aneroid barometer.
10. Why does a piece of iron sink but a ship made of the same iron floats?
11. State the principle of flotation.
12. What are the factors on which the pressure exerted by a liquid depends?
13. Describe an experiment which shows that a liquid exerts lateral pressure
14. What do you understand by a buoyant force?
15. What keeps the mercury in a mercury barometer from flowing out of the tub?

B. Fill in the following blanks:

1. Thrust is
2. Pressure is the amount of thrust
3. Liquid tends to find its own
4. Hydraulic brakes work on the principle of
5. One atmosphere is equal to bar.

C. Decide whether the following statements are TRUE/FALSE:

1. Pressure increases as force increases.
2. Pressure is force per unit area.
3. Pressure in a liquid does not change with change in depth.
4. Weight is expressed in units of force.
5. Difference of pressure causes movement of a fluid.
6. S.I unit of thrust is meter.
7. The pressure exerted by air is called hydraulic pressure.
8. Submarine is an example of principal of floatation.
9. Barometer is used to measure humidity.
10. Air exerts pressure.

TRUE

FALSE

Homework Assignment



Search and study how low pressure situation in space is handled by astronauts and spaceships. Also study about the training procedure that astronauts go through before space travel. Write a note on your findings.

FUN WITH SCIENCE

Fill a glass tumbler completely with water and place a cardboard disc or thick paper on it. Hold the disc in position with your hand and invert the tumbler. Now, remove your hand supporting the disc. You will see that the disc does not fall off (Fig. 11.27). This activity shows that air exerts pressure upwards from below and balances the weight of water in the tumbler as shown in Fig. 11.27.



Fig. 11.27 Air exerts pressure upwards from below.

The Current Electricity

Learning Objectives

At the end of this unit, students should be able to:

- understand and define current electricity.
- understand and explain the direction of electric current.
- measure the quantity of electricity.
- understand the introductory concept of electric potential and potential difference.
- know the various ways to produce electricity.
- demonstrate and explain induced current by relative motion of magnet and a coil.
- understand and define electric circuit, its types and symbols of circuit elements.
- understand and explain the hazards of electricity.
- understand the safety measures adopted while handling any electrical circuit or appliance.
- know that electric power determines the consumption of electric energy and 'kwh' is the unit used to estimate the cost of electricity being consumed.

INTRODUCTION TO ELECTRICITY

Electricity is a form of energy that results from the existence of charged particles.

Electricity plays a very important role in our daily life. It lights, heats and cools our home and performs a number of daily routine jobs for us. Televisions, radio, cinema projectors, videos, computers, telephones, telegraphs, refrigerators, microwave oven, juicer, grinder, blender, ..., etc. run on electricity. It illuminates our streets, helps to advertise business and operates electric trains. Thus, most of the charm of modern life would be no more, if there were no electricity. In all these cases, electricity moves through the electric wires. Electricity in motion is called **current electricity**.

ELECTRIC CURRENT

Let us perform the following activities to learn more about the electric current.

ACTIVITY TIME!

Take an electroscope and charge it negatively. Now, connect the disc of the electroscope to a tap using a wire having insulating coverings. What do you observe? You will find that the leaves of the electroscope collapse. This is due to the fact that the electrons on the electroscope flow through the wire to the earth.

ACTIVITY TIME!

Take a positively charged and a negatively charged electroscopes and connect them through a metal wire as shown in Fig. 12.1. What do you observe? You will find that both the electroscopes are discharged quickly. Why? The fact can be explained on the basis of flow of electrons. The excess of electrons on the negatively charged

electroscope flows through the conducting wire to the positively charged electroscope and neutralizes the excess of positive charge on it. Thus, when the excess of negative charge i.e. the electrons on the negatively charged electroscope flow through a conducting wire to the positively charged electroscope having electron deficiency, both are discharged quickly.

You have seen that when two charged bodies having different states are joined through a conducting wire, electrons flow through the wire. This directed flow of electrons in a conductor is called an electric current.

Now, you must have understood clearly that electrons flow through the conducting wire connecting two charged conductors from the one having surplus of electrons i.e. the negatively charged conductor to the one having deficit of electrons i.e. the positively charged conductor. This flow of electrons will stop as soon as the surplus or deficit of electrons on both the conductors becomes equal.

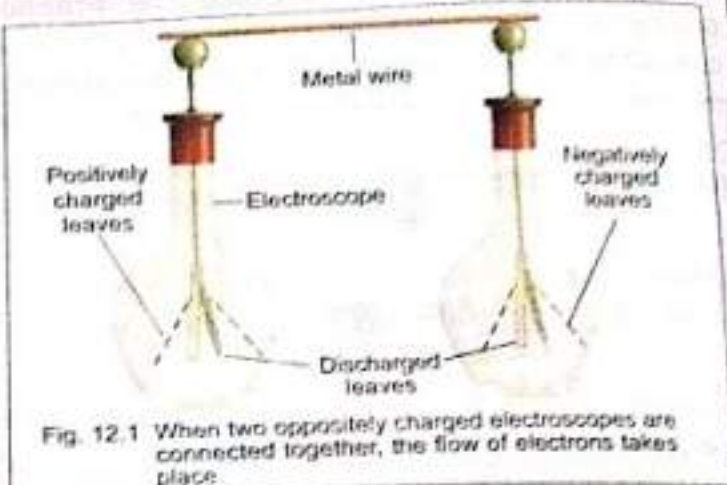


Fig. 12.1 When two oppositely charged electroscopes are connected together, the flow of electrons takes place.

Thus, it is clear from the above discussion that electric current or current electricity is actually the flow of electrons through a conductor and for the continuous flow of electrons through the conducting wire, the supply of surplus electrons on one conductor has to be maintained. Therefore, for production of electric current, we require:

1. Freely moving charges.
2. An electric field to force the charges to move in a particular direction.

Electric current is represented by the symbol 'I'

ELECTRIC CURRENT AND ITS DIRECTION OF FLOW

It has been a convention to say that electric current flows from the positive end of a wire to its negative end. In fact, in a metallic wire it is the electrons which drift in the direction from the negative end to the positive end of the wire. We call this current as the **electronic current**. The electronic current is equivalent to **conventional current** flowing from the positive to the negative end of the wire.

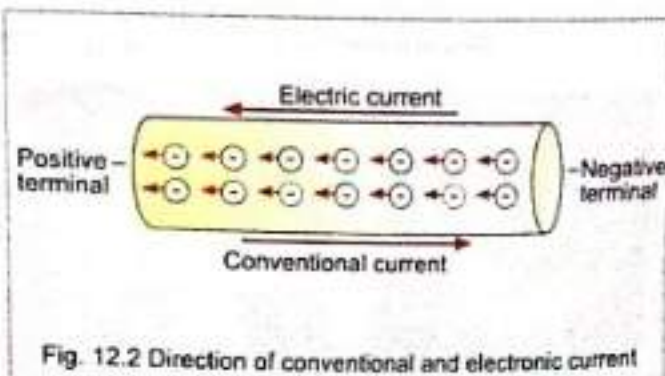


Fig. 12.2 Direction of conventional and electronic current

The cell is the source of electrons. The direction of flow of electrons is from negative to positive terminals of the cell as shown by the arrow in Fig. 12.3. The direction of conventional current is from positive to the negative terminal of the battery. This is shown in Fig. 12.4.



Fig. 12.3 Direction of flow of electrons



Fig. 12.4 Direction of conventional current

MEASURING ELECTRICITY

If current ' I ' flows in a wire for a time ' t ', the quantity of electricity or charge ' Q ' transferred is represented as:

$$Q = It$$

(Conversely, the current may be defined as the quantity of electricity that flows in one second across a cross-section of the wire. It is represented as:)

$$I = Q / t$$

The S.I unit of electric current ' I ' is the ampere (A), of charge Q is Coulomb (C) and time ' t ' is second (s). Therefore, if 1 Coulomb of charge flows through a conductor in 1 second, the amount of current will be 1 ampere.

We measure the quantity of an electric current using an **ammeter** as shown in Fig. 12.5. The instrument is so named because it measures electricity in amperes.)



Fig. 12.5 Using an ammeter

POTENTIAL DIFFERENCE

Connecting a positively charged body to a negatively charged or an uncharged body results in an electric current flowing for a short period only. It is similar to connecting together two vessels with water filled up to different levels through a pipe (Fig. 12.6a). Water flows until

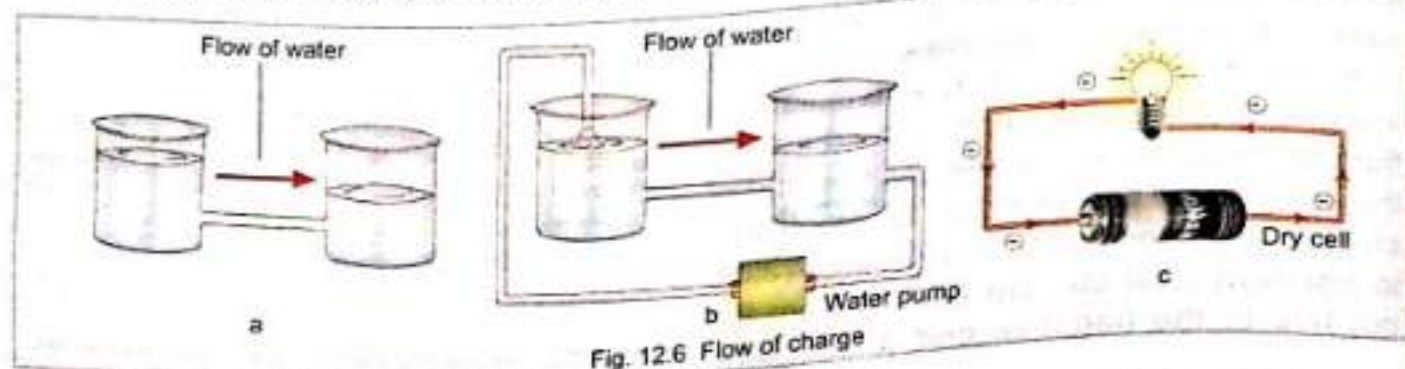


Fig. 12.6 Flow of charge

the water levels and hence the water pressure becomes the same in the two vessels. To make the water flow continuously, you need to connect a water pump to the second vessel which constantly pumps the water back to the first vessel. In this way, the level and hence the pressure of water in the first is always higher and the flow of water is continuous (Fig. 12.6b).

Water flows continuously because of the 'pressure difference' in the two vessels maintained by the pump.

To make an electric current flow continuously, you need a device that can constantly 'pump' charges in the same way to create a 'charge difference'. In terms of electricity, it is known as **potential difference**.

Thus, if conventional current flows from point A to point B in a wire, we say that A is at a higher potential than B, or that there is a potential difference between A and B. Note once again that conventional current and not electronic current is said to flow from high to low potential. This is carried forward from the times when an electric current was thought to be the flow of positive charge, and has not been changed even today.

The S.I unit of potential difference is **volt (V)**. It is measured with a **voltmeter**.

POTENTIAL DIFFERENCE IN A DRY CELL

A dry cell is a device that can make charges move continuously in a wire by creating a potential difference. A dry cell has two terminals-one marked positive (+) and the other marked negative (-). The positive terminal is at a higher potential than the negative terminal. When these terminals are connected by a metal wire, conventional current flows from the positive terminal to the negative terminal in the wire. Note that electrons flow from the negative terminal to the positive terminal in the wire.

If a torch bulb is connected to the wire as shown in Fig. 12.6c, it lights up because moving electrons have energy called **electric energy**.

PORTABLE SOURCES OF ELECTRIC CURRENT

Some of the common portable sources of electric current are:

- | | |
|-----------------|------------------------|
| 1. Voltaic cell | 2. Daniel cell |
| 3. Dry cell | 4. Storage battery |
| 5. Solar cells | 6. Generator or dynamo |

made it

1. Voltaic cell (Galvanic cell)

The first cell that could make an electric current flow in a wire was made by two Italian scientists named **Luigi Galvani** and **Alessandro Volta** in 1799. It is also called a simple cell. It consisted of a copper plate and a zinc plate dipped in dilute sulphuric acid taken in a glass vessel.



Fig. 12.7 Luigi Galvani



Fig. 12.8 Alessandro Volta

When the two plates were connected by a copper wire with a bulb in between, the bulb glowed showing the flow of electric current. It was found that electrons flowed in the wire from the zinc to the copper plate.

The copper and zinc plates are called the **electrodes** of the cell. Zinc is the negative electrode or **anode** as it supplies the electrons and copper is the positive electrode or **cathode**. Dilute sulphuric acid is the **electrolyte**. The copper electrode is at a higher potential than the zinc electrode. Therefore, conventional current flows from the copper electrode to the zinc electrode in the wire. The electronic current flows in the opposite direction. The potential difference between the two electrodes is **1.5 V**. This potential difference is called the **electromotive force** or **emf** of the cell.



Fig. 12.9 First Voltaic cell

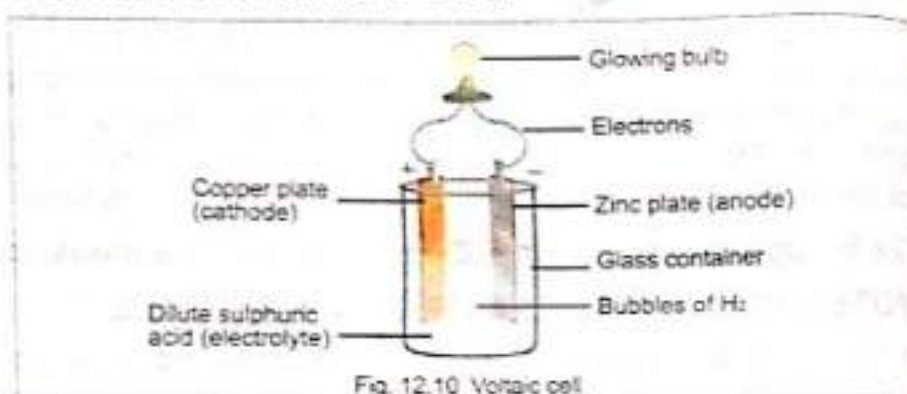


Fig. 12.10 Voltaic cell

If you make a Voltaic cell yourself and use it to light a bulb, you will find that the glow of the bulb becomes dimmer and dimmer and in a few minutes it goes out. If you now look at the copper plate you will find that it is covered with small bubbles of a gas. The gas is hydrogen, which is produced as a result of chemical reaction that takes place in the cell. This layer of hydrogen prevents further reaction and the action of the cell stops. That is why the Voltaic cell is not a good source of electric current.

2. Daniel cell

This cell was invented by J.F. Daniel in 1836. A Daniel (Fig. 12.12) cell consists of a copper



Fig. 12.11 J.F. Daniel

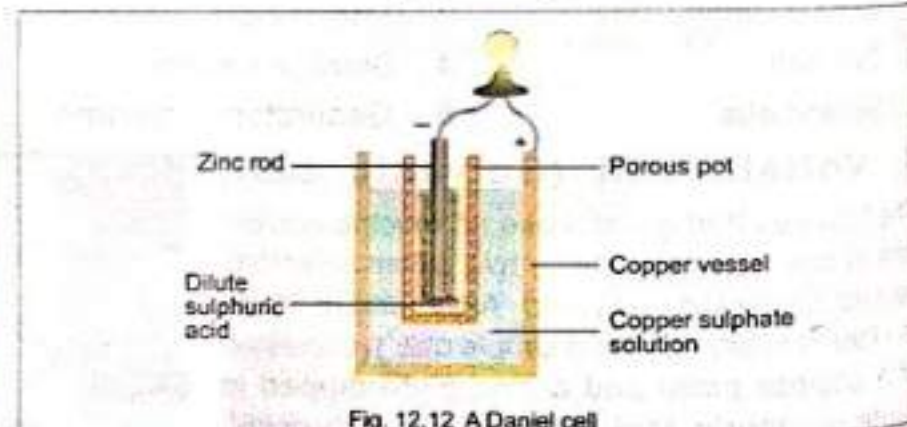
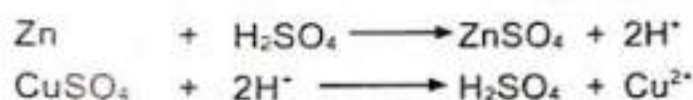


Fig. 12.12 A Daniel cell

vessel containing copper sulphate solution. A porous pot filled with dilute sulphuric acid or zinc sulphate is kept in the copper vessel. The copper vessel serves as the cathode and a zinc rod, dipped into the acid in the porous pot, serves as the anode. If the cathode and anode are connected by a metal wire, electrons flow in the wire from the zinc rod (anode) to the copper vessel (cathode).

The reactions that take place are as follows.



In the outer circuit, electrons flow from zinc rod to copper vessel.

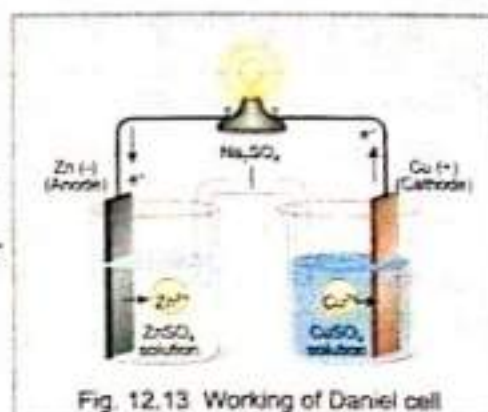
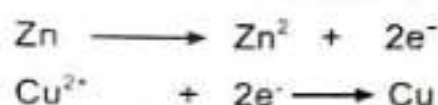


Fig. 12.13 Working of Daniel cell

3. Dry cell

The problem with earlier cells was that they contained liquids and were, therefore, cumbersome to carry. This shortcoming was overcome with the invention of the dry cell, which is now commonly used in torches and electronic appliances. Dry cell was invented by a French scientist **G. Leclanche** in 1866.



Fig. 12.14 G. Leclanche

A dry cell consists of a zinc container, which also serves as the negative terminal. The electrolyte is a paste of ammonium chloride. A carbon rod with a brass cap serves as the positive electrode. It is surrounded by a paste of powdered manganese dioxide and carbon particles (Fig. 12.15). In the dry cell also, hydrogen is formed in the chemical reactions that take place in the cell. The manganese dioxide reacts with the hydrogen formed and prevents it from collecting on the zinc electrode.

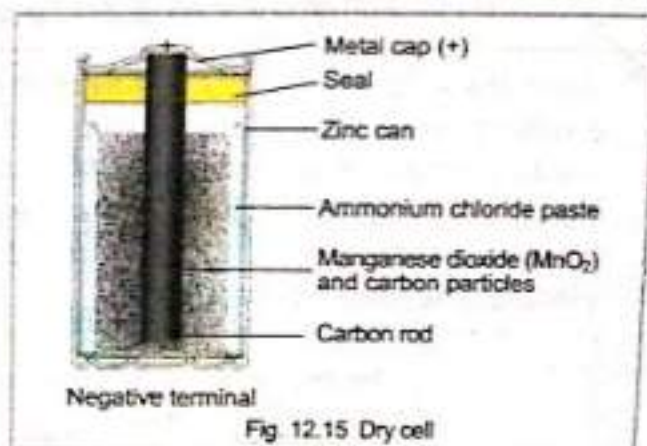


Fig. 12.15 Dry cell

A seal at the top prevents the chemicals from drying out. The cell is dry from outside but the chemicals must be kept moist, otherwise it will not work. The electrons flow in a wire connecting the two terminals from the zinc to the carbon electrode.

ADVANTAGES OF A DRY CELL

1. It is compact in size.
2. It is light and easy to carry from place to place.
3. It is convenient to use.

DISADVANTAGES OF A DRY CELL

1. It produces small currents for a relatively short period of time.
2. It can not be reused when it is discharged.

ACTIVITY TIME! To study parts of a dry cell.

Take a used cell. First take off the cardboard wrapping and you will find a metal container made of zinc. Tear off some of the zinc casing of the cell with a pair of pliers. Inside, you will see a whitish jelly like substance round a black sticky powder. Can you name these substances? Now grip the brass cap at the top tightly with the pliers. A firm twisting pull will draw out a black rod made of carbon (Fig. 12.16).

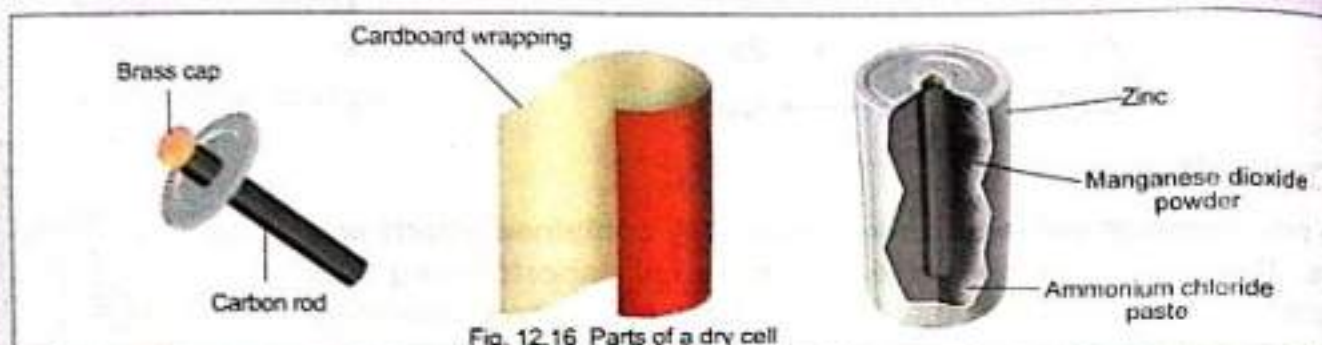


Fig. 12.16 Parts of a dry cell

ACTIVITY TIME! To verify the flow of electrons in a dry cell.

Wash the strip of zinc you tore from the cell and clean it with a sand paper. Connect a wire to one end of the zinc strip. Now take a juicy lemon, cut a slit in it and push the zinc strip in it. Cut another slit close by and push in the carbon rod. Your cell is ready. Here the lemon juice is the electrolyte. Now test this cell with the tip of your tongue as shown in Fig. 12.17. What do you feel? You will feel a slight tickling because electricity is passing through it.

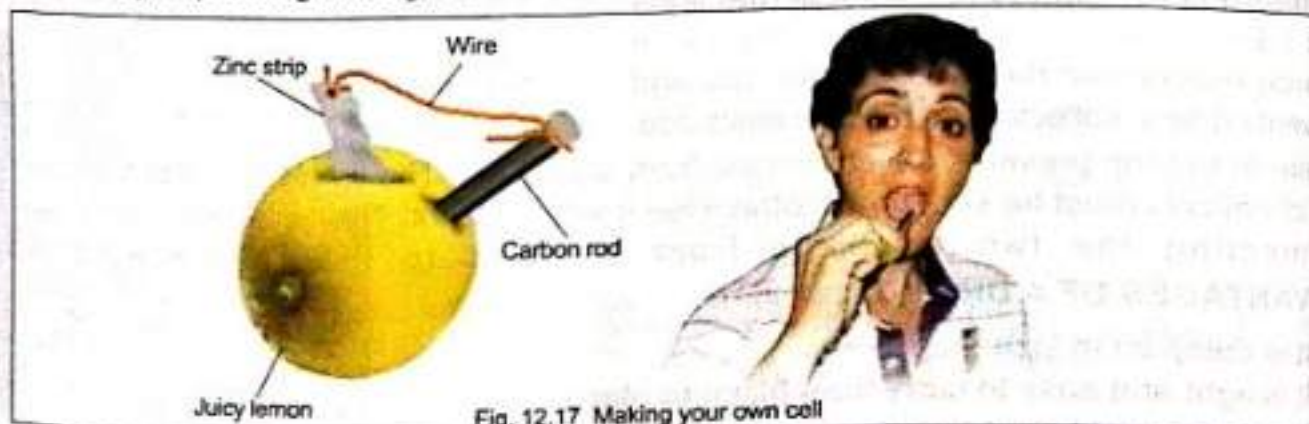


Fig. 12.17 Making your own cell

4. STORAGE BATTERY

Most cells are not rechargeable. They can not be reused when they are discharged. They have to be replaced with new cells. Such cells are called **primary cells**.

There are some cells which can be recharged and used again and again after recharging. Such rechargeable cells are called **secondary cells, storage cells or accumulators**.

Types of accumulators

There are two types of accumulators:

1. Lead-acid accumulator.
2. Nickel-cadmium alkaline accumulator.

Lead acid accumulator is the common type of storage cell. It consists of several plates of lead dipped in H_2SO_4 . The H_2SO_4 acts as an electrolyte. A grid of lead packed with lead dioxide (PbO_2) acts as an anode. Each cell consists of number of cathode and anode plates. One cell gives a voltage of about 2 volts. Six cells, joined in series in car battery, give a voltage of about 12 volts. The storage battery used in cars is shown in Fig. 12.18.

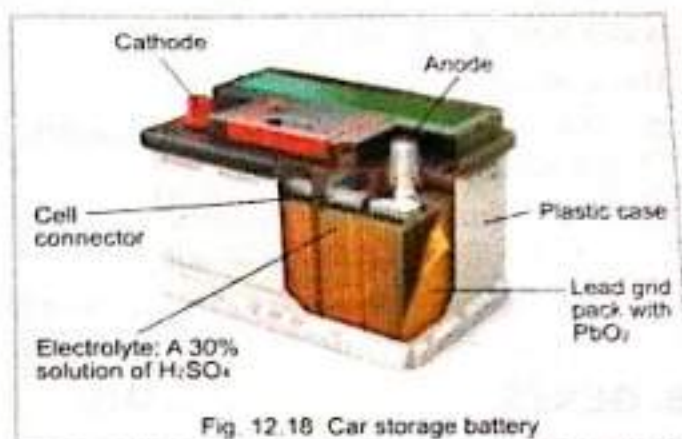


Fig. 12.18 Car storage battery

Uses of storage batteries

- Storage batteries are extensively used in cars, buses, trucks etc. and other vehicles for ignition and lighting.
- They are also used for illuminating railway carriages.
- They are also used in submarines, radio transmitters and satellites.

Advantages of storage batteries

1. They can be recharged a number of times.
2. They produce a large current for a long duration.

Disadvantages of storage batteries

1. They are quite heavy.
2. They require good maintenance.
3. They are expensive.

Good to know

Voltaic cell, Daniel cell, dry cell and accumulators are called electrochemical cells because in these cells, chemical energy is converted into electrical energy.

5. SOLAR CELLS

Solar cells are also used as a source of electric current. A simple solar cell consists of a wafer of silicon in which some arsenic atoms have been embedded. This wafer is coated with a thin layer of silicon and boron. As the sunlight strikes the silicon wafer, a small electric current is produced. For obtaining a sizeable current, a very large number of solar cells is connected together to form a solar panel. Current can be transmitted from the wafer through the wires.

Uses of solar cells

- ❑ They are used in watches, calculators, transistors and satellites.
- ❑ Solar furnaces, solar heaters and solar cookers also make use of solar cells.
- ❑ These cells are also used in remote parts of the country for generating electricity.



Fig. 12.19 Solar panel charger

6. GENERATOR (OR DYNAMO)

Generator or dynamo is a device for producing electric currents for use in home and industry. It converts mechanical energy into electrical energy.

The principle of working of a dynamo or the huge generators in power houses and dams is the same. They all essentially consist of a magnet moving rapidly within a coil of copper wire. The current is drawn from the two ends of the coil. The greater the speed of rotation, the greater is the current produced.

A cell can be used to operate a torch or a toy fan. But it cannot run refrigerators or light up larger bulbs. The electricity supplied to our house is generated by large machines called **generators**.

The principle on which generators work was discovered by **Michael Faraday in 1831**. He showed that a current is produced (or induced) in a coil of wire when a magnet is moved in and out of the coil. Alternately, the magnet can be kept stationary and the coil moved. Thus, he concluded that **electric current is induced in a coil as long as there is relative motion between the coil and the magnet kept close to it**. This is known as the **principle of electromagnetic induction**.

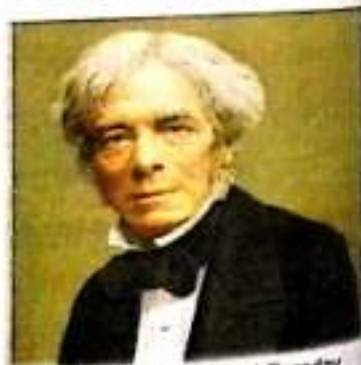
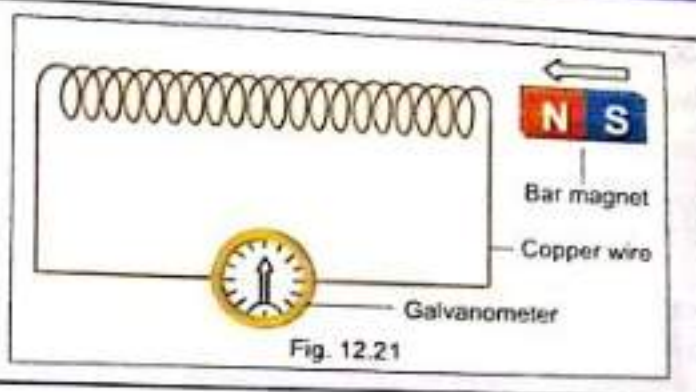


Fig. 12.20 Michael Faraday

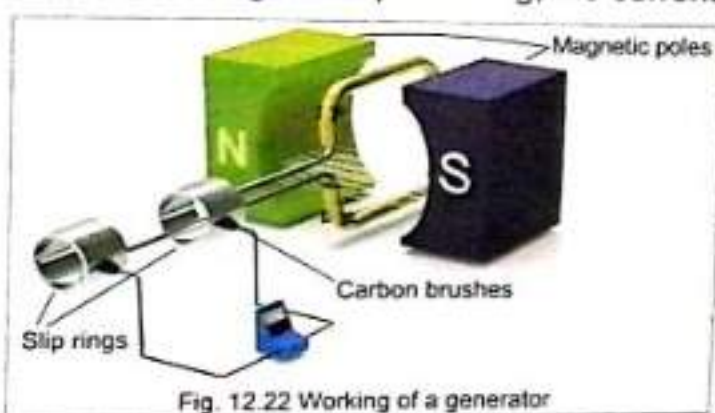
ACTIVITY TIME! To test the principle of electromagnetic induction.

You will need some insulated copper wire, a bar magnet, and an instrument called a galvanometer which can detect current. Make a coil of copper wire by winding

closely 20-25 turns of the wire around a cylindrical object such as gum tube. Remove the tube and connect the two ends of the wire to the galvanometer. Make sure that magnet can go in and out of the coil. Quickly insert the magnet in the coil. Does the needle of the galvanometer deflect for a moment?



You will notice that the needle deflects, showing that a current is induced in the coil, as long as the magnet is moving through it. As soon as the magnet stops moving, the current returns to zero. Now if you quickly take the magnet out of the coil, you will notice that the needle again deflects, but this time in the opposite direction. This shows that when the magnet moves in the opposite direction, the current is also induced in the opposite direction. If you rapidly move the magnet in and out of the coil, you will be able to induce a current that rapidly changes directions. The generator uses this principle to generate electricity. It consists of a rectangular coil having a large number of turns, free to rotate about a horizontal axis within the poles of a powerful U-shaped magnet. The coil is connected to two **slip rings** against which **carbon brushes** press lightly. When the coil is rotated, electric current is generated. The current can be supplied through wires connected to the brushes.



Good to know

In a bicycle dynamo, the movement of the wheel is used to move the coil. In the small generators that are used to supply power during power cuts, a petrol or kerosene engine is used to rotate the coil.



COMMERCIAL PRODUCTION OF ELECTRICITY

Following are the common means for the large scale production of electricity:

- (i) THERMAL POWER PLANT
- (ii) HYDRO ELECTRIC POWER PLANT

(ii) NUCLEAR POWER PLANT

(i) Thermal power station

In this type of electric power station, steam is created by heating water with the help of

coal, oil, gas, waste materials etc. The steam is the source of mechanical energy that runs turbines. These running turbines run the generator. In Pakistan, such thermal power plants



Fig. 12.24 Thermal power station

are working in Hyderabad, Jamshoro, Multan, Quetta etc.

This method of generating electricity is expensive. Burning of coal, oil, gas, waste materials

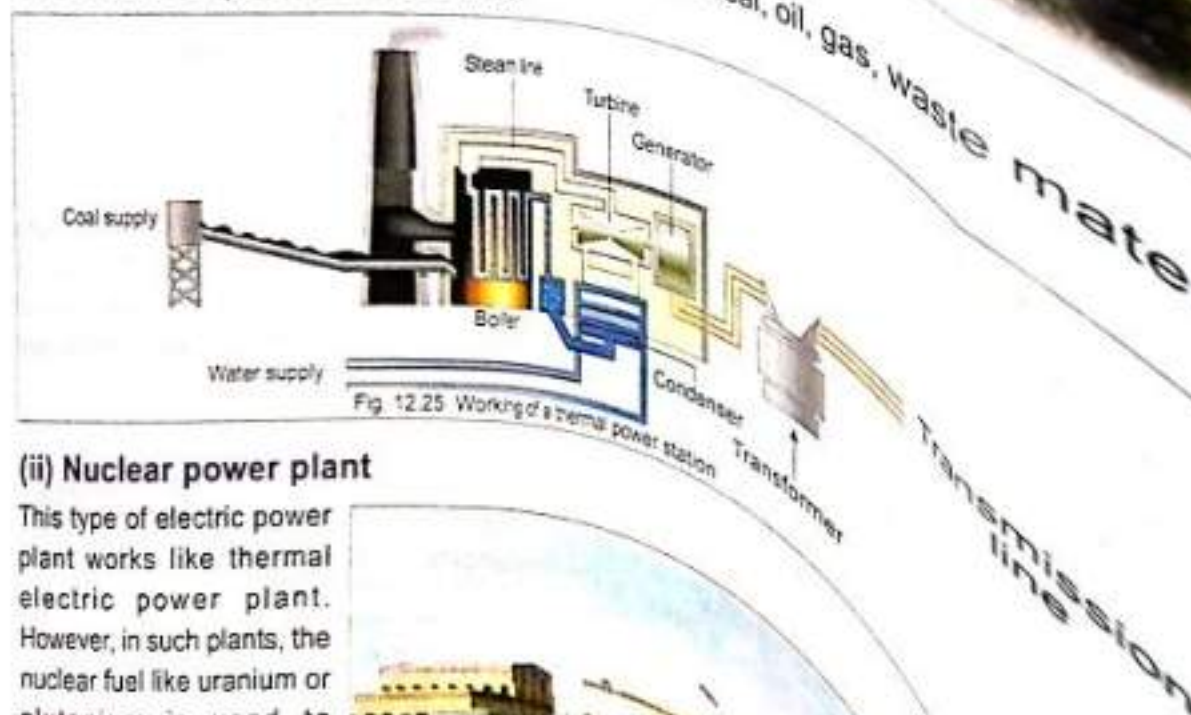


Fig. 12.25 Working of a thermal power station

(ii) Nuclear power plant

This type of electric power plant works like thermal electric power plant. However, in such plants, the nuclear fuel like uranium or plutonium is used to generate electricity. In such method, heat energy is produced by a process called NUCLEAR FISSION. In this process, energy is



Fig. 12.26 Karachi Nuclear Power Plant

released from the nuclei of the atoms when they are broken. In our country, such a Nuclear Power Plant is working in Hub near Karachi. It is also known as 'KANNUP' (Karachi Nuclear Power Plant). Chashma Nuclear Power Plant has also been built to meet the demand of electricity in our country.

(iii) Hydroelectric power plant

Some of the power plants use flowing water as a source of mechanical energy. A power plant in which electricity is generated by flowing water from dams is called Hydroelectric Power Plant (Fig. 12.27).

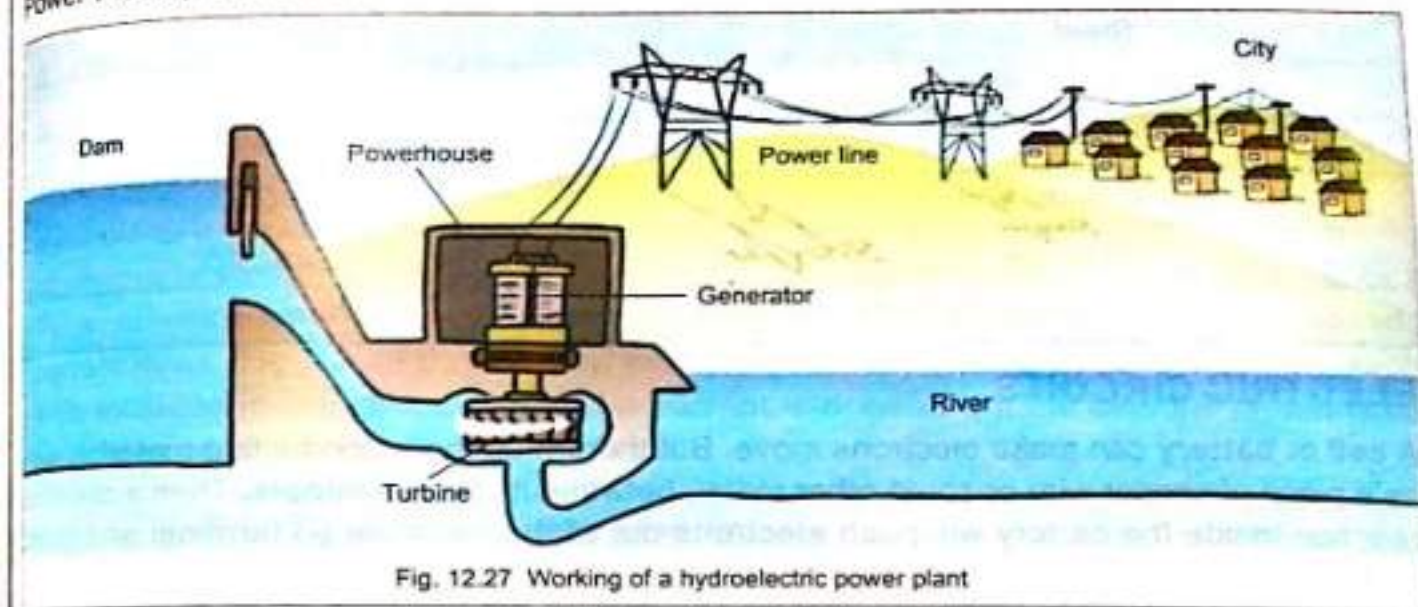


Fig. 12.27 Working of a hydroelectric power plant

Water is stored in a lake or reservoir at a height behind the dam. When water is allowed to fall from the height, it gains kinetic energy. Kinetic energy of the moving water flowing through the tunnels is used to turn the blades of turbines. These are attached to the lower end of the axle of the electric generator. This generator produces electricity which is supplied to the consumers through power lines. This type of plants are low cost and produces negligible pollution. In Pakistan, such type of power stations are working at Tarbela, Warsak, Mangla and Ghazi Brotha.

CONDUCTORS AND INSULATORS

We find that some substances allow electricity to flow through them while others do not. Substances which allow electricity to flow through them are called **conductors**. On the other hand, substances which do not allow electricity to flow through them are called **insulators**.

The table 12.1 shows which of the substances are conductors of electricity and which of the substances are insulators.

Table 12.1 Some conductors and insulators

Conductors	Insulators
Silver	Cotton
Gold	Rubber
Aluminium	Plastics
Iron	Mica
Brass	Wood
Steel	Paper
Moist air	Glass
Tap water	Leather
Human body	Ebonite
Charcoal	Pure water
Acids/Bases/Salts	Dry air

ELECTRIC CIRCUITS

A **cell** or **battery** can make electrons move. But there must be a conducting material, such as a piece of copper wire or some other metal, between its two **terminals**. Then a chemical reaction inside the battery will push electrons out of the negative (-) terminal and round to the positive (+) terminal.

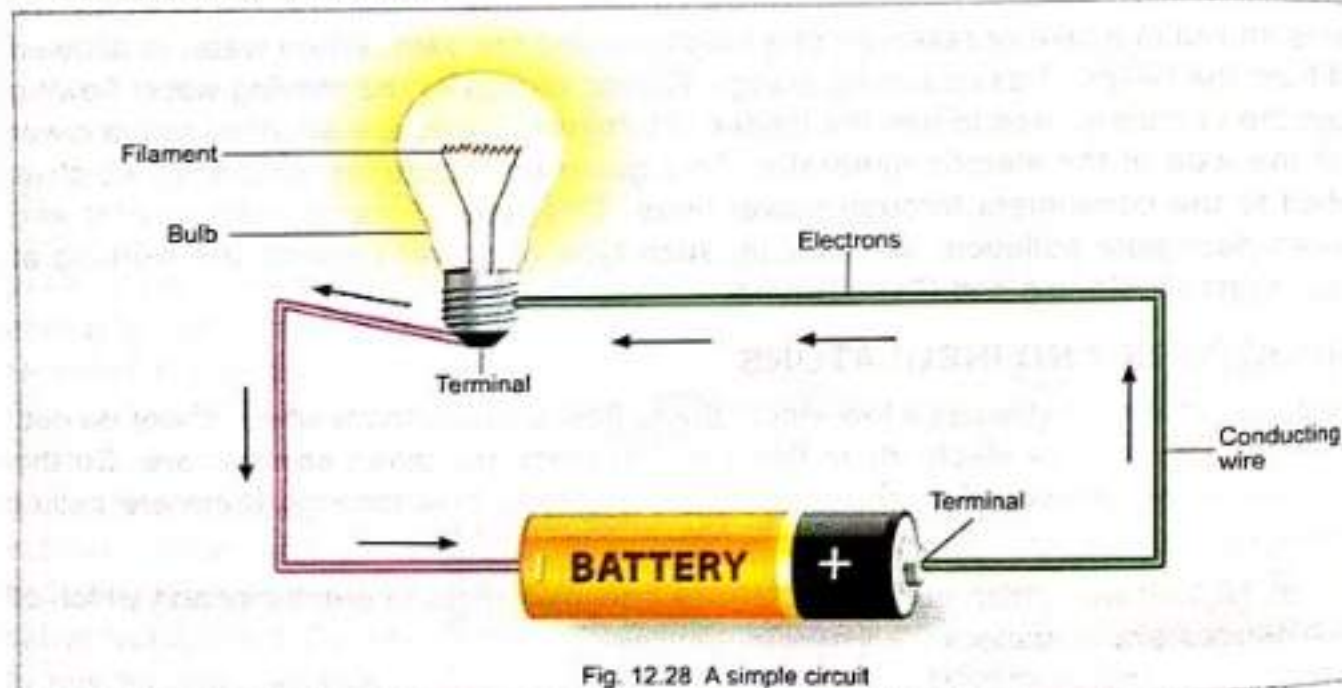


Fig. 12.28 A simple circuit

The cell in the picture above is being used to light up a torch bulb. The conducting path through the bulb, wires, and cell is called an **electrical circuit**. As the electrons pass through the thin wire or **filament** inside the bulb, they make it heat up so that it glows.

Components of an Electric Circuit

The essential components or elements of an electric circuit are given below:

1. **Electric sources** (cell, battery etc.)
2. **Electric appliances** (a device for using the electric current).
3. **Conductor** (for providing a path for the flow of current).
4. **Switch or a key** (for opening and closing the circuit).

Open and Closed Circuit

If we place a switch in the circuit and if the switch is opened or the wire is cut, the flow of current is stopped and we say that the circuit is **open** or **incomplete** (Fig. 12.29 a). Thus, in an open circuit, no current is drawn from the cell. If the switch is closed, a current flows (Fig. 12.29 b). The flow of current is indicated by the glowing of an electric bulb included in the circuit. Thus, if a current is drawn from the cell, the circuit is said to be **closed** or **complete**.

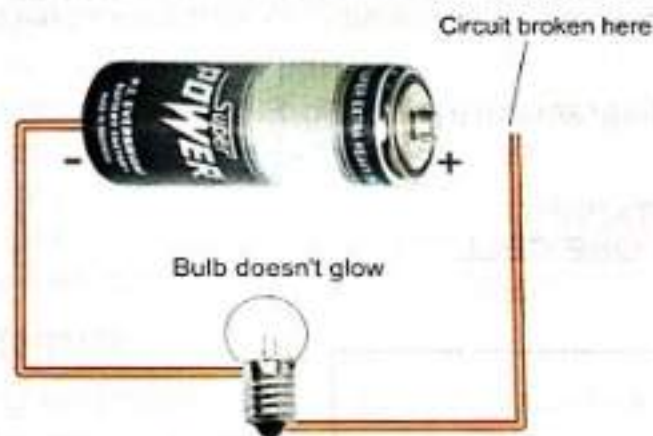


Fig. 12.29 (a) Open or incomplete circuit



Fig. 12.29 (b) Closed or complete circuit

Symbols of Circuit Components

The conventional symbols for some common elements of electric circuit are given in Table 12.2.

UNIT - 12

Table 12.2 Symbols of circuit elements

Name of element	Symbol of the element
A single electric cell/battery	
Battery of dry cells	
An electric bulb	
Open switch or key	
Closed switch or key	
A wire joint	
Ammeter	
Voltmeter	
Galvanometer	

Circuit Diagram

A circuit diagram indicates the arrangement of different circuit elements with their conventional symbols.

Some of the most commonly used circuit diagrams are given in Figs. 12.30, 12.31 and 12.32.

1. A CIRCUIT CONTAINING ONE BULB AND ONE CELL

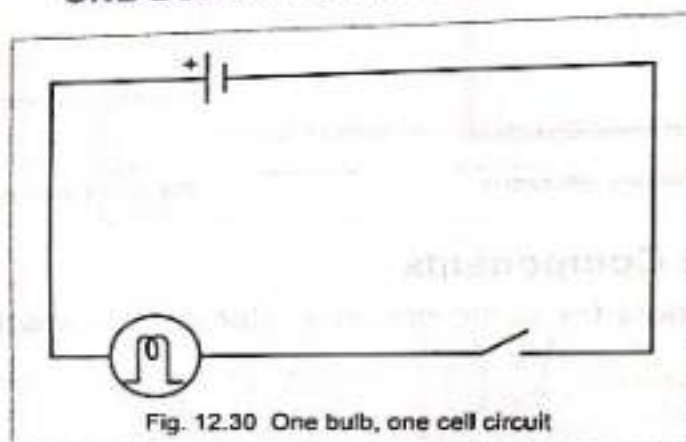


Fig. 12.30 One bulb, one cell circuit

2. A CIRCUIT CONTAINING TWO CELLS AND ONE BULB

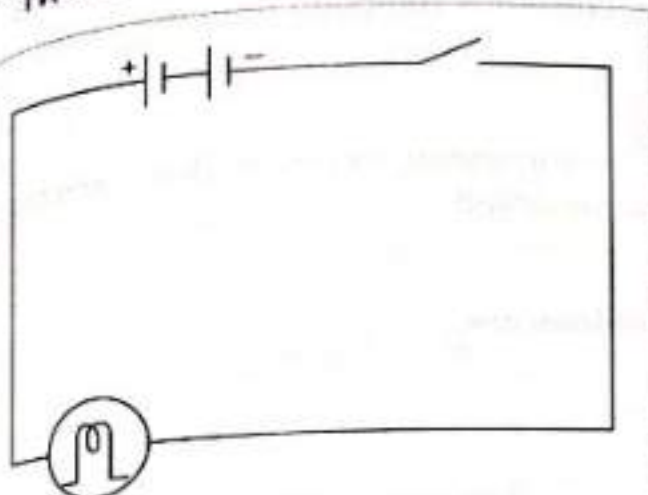


Fig. 12.31 Two cells, one bulb circuit

3. A CIRCUIT CONTAINING THREE CELLS AND ONE BULB

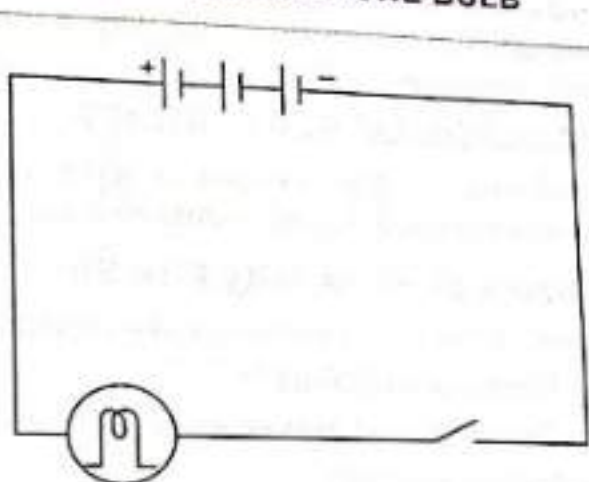


Fig. 12.32 Three cells, one bulb circuit

ELECTRIC FUSE

An electric fuse is just a short piece of wire of low melting point. It is made of an alloy of tin and lead because they have very low melting points. It is connected in series in an electrical appliance or in the mains. When the current exceeds a particular value (due to defective wiring or short circuit), the fuse melts and the circuit is broken. Safety fuses, thus, prevent the accidental flow of large current which may damage electrical appliances or cause a fire. Fig. 12.33 shows an electric fuse commonly used in a household circuit.

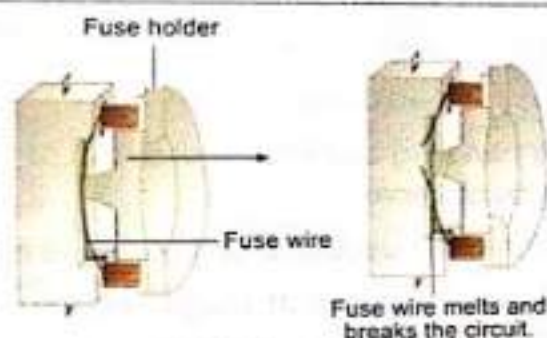


Fig. 12.33 Working of an electric fuse

EARTHING

Earthing or grounding an electrical appliance is as important as a provision of safety fuse. All electrical appliances are usually provided with an earth or grounded wire which is

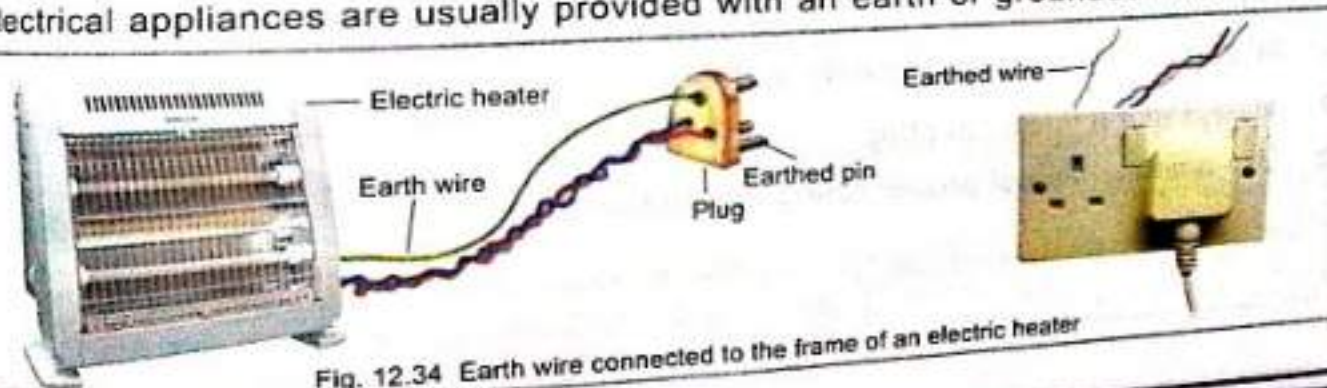


Fig. 12.34 Earth wire connected to the frame of an electric heater

connected to the frame of the appliances as shown in Fig. 12.34. In case of contact of metal casing of the appliance with a live wire, the current passes through the earth wire and goes to the earth. In this way, a dangerous current is removed from the casing that can harm users.

HAZARDS OF ELECTRICITY

Electricity could be dangerous and may cause electric shock, death, accident and fire, if certain precautions and safety measures are not observed.

Causes of Electricity Fire/Shocks

Some of the causes which make electricity hazardous are:

1. Loose connections
2. Defective and broken switches
3. Improper wiring
4. Poor insulation of wiring
5. Over loading
6. Improper earthing

Safety Measures

While handling any electrical circuit or any electrical appliance, the following precautions must be observed.

- ❑ The wires used in a circuit should be of good quality, proper amperage and insulation.
- ❑ All connections at plugs, switches, sockets and junctions must be covered with insulating tape.
- ❑ Defective and damaged plugs, switches and sockets must be immediately replaced.
- ❑ Do not insert your fingers in the socket fixed on the walls of your room.
- ❑ The tools used for repairing such as testers, screw drivers, pliers etc. should have proper insulation.
- ❑ The main switch should be immediately switched off in case of fire or short circuit.
- ❑ All appliances must be properly earthed.
- ❑ Always use a three pin plug.
- ❑ Use a safety fuse of proper rating and material.

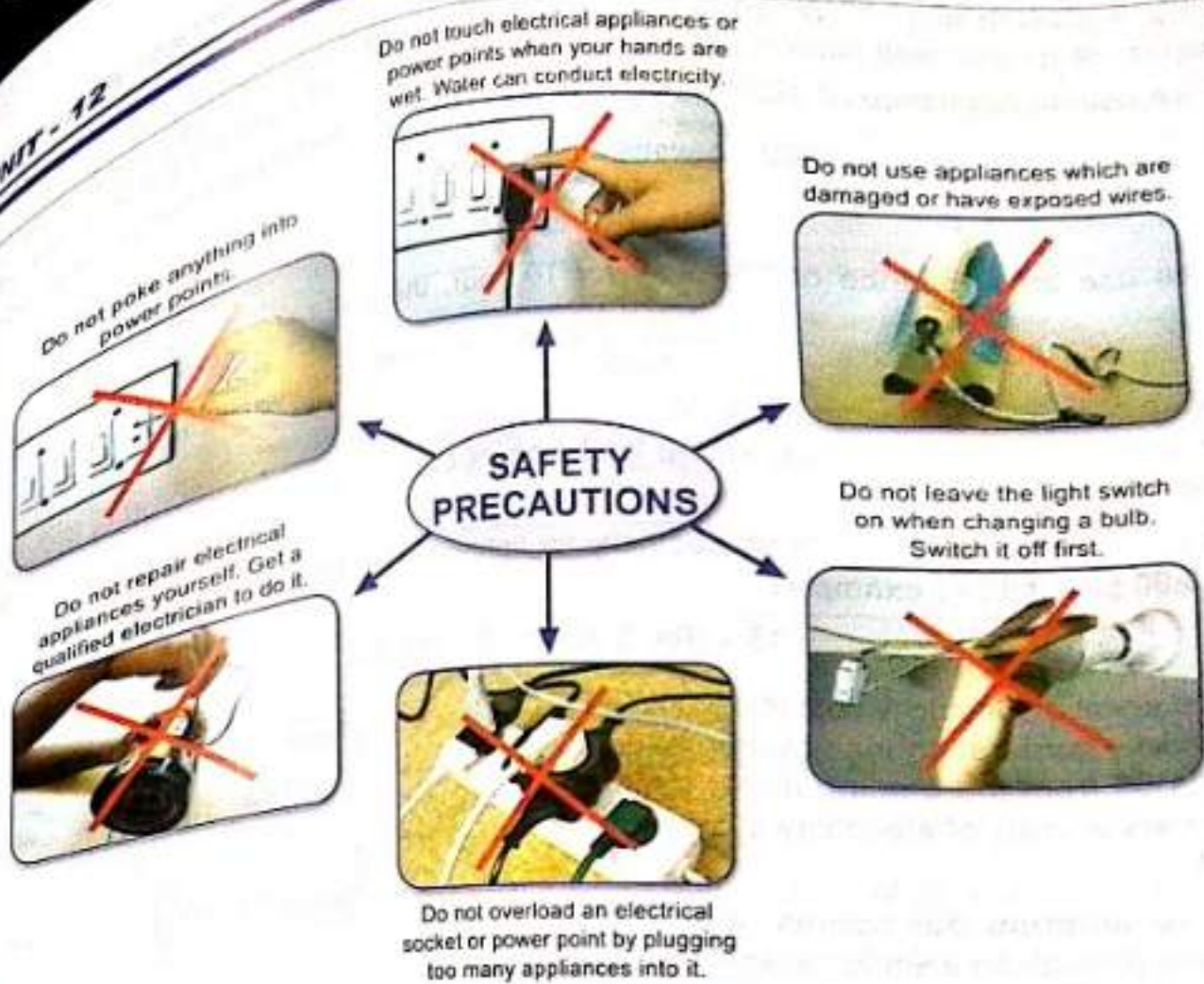


Fig. 12.35 Safety precautions to take when using electricity

THE COST OF ELECTRICITY

The electrical energy can be converted into heat, light, sound and mechanical energy in the household appliances. The rate at which the electrical energy is transferred from one form to another is called electric power.

Power is measured in watts. One watt (w) is the power of a machine or device where energy is being used up or produced at a rate of one joule per second. (1 watt = 1 joule/sec). Electric power is calculated using the following formula:

$$\text{Power (P) in watts} = \text{Current (I) in amperes} \times \text{Voltage (V) in volts}$$

$$P = IV$$

How much electricity a particular appliance will use will depend upon its power (rate of using energy) and the length of time that is used. The unit in which this electricity usage is measured is the Kilowatt hour-which means using one kilowatt (kW) of power for one

hour. A kilowatt is 1000 W. So, a kWh of electricity would also be used, if we had an appliance of one watt running for 1000 hours, one of 500 W running for 2 hours etc. If we use an appliance of 1000 watt power for 1 hour, the electrical energy used up is

$$1000 \times 1 \text{ watt/hour} = \frac{1000 \times 1}{1000} \\ = 1 \text{ kilowatt-hour}$$

If we use an appliance of 100 watt for 10 hour, the electrical energy used up is

$$\frac{100 \times 10}{1000} = 1 \text{ kilowatt-hour}$$

The kilowatt-hour is the electrical unit which is used by the electricity corporation to charge our consumption of electricity or the total amount of units (kWh) of electricity we have used.

If a consumer used 15 units of electricity for lighting, then he has to pay at the rate of Rs.3.00 per unit (for example)

$$15 \times (\text{Rs. } 3.00) = \text{Rs. } (45.00)$$

Since a unit of electricity cost Rs. 3.00. The electricity corporation man (meter reader) reads off from the electric meter to note numbers of units of electricity a consumer uses.

Before entering our homes, electricity passes through an electric meter. It records the electric energy passing through it. Digital displays on the meter show the number of units of electricity used.



Fig. 12.36 Electric meter

Electrical Appliances and their wattage

Appliance	Wattage	Appliance	Wattage
Light bulb	60 W 100 W	Refrigerator	100 W
Hair dryer	1250 W	Electric oven	3800 W
Iron	800 W	Television	400 W
Toaster	1140 W	Smallest air conditioner	500 w

 Amazing facts!

You have read about conductors and insulators. There are some materials that are mid-way between conductors and insulators in their ability to pass electricity. They are known as semiconductors. Semiconductors are extremely useful in the field of electronics. Without them, it would not have been possible to produce small transistor-radios, calculators, computers and a number of other electronic equipments.

 Teacher's corner

Conduct a class presentation in which inform students about the need of construction of more hydro-electric power plants in Pakistan.

 Let's work in team!

Under the supervision of your teacher, construct a working Daniel cell, demonstrate its working to students of other classes.

 KEY POINTS

Here is a list of key points to remember:

- 🔑 Electricity plays a very important role in our daily life.
- 🔑 Directed flow of electrons in a conductor is called an electric current.
- 🔑 Electrons flow from negative to positive terminal of the battery.
- 🔑 Current is the rate of flow of charge i.e. $\text{current} = \text{charge}/\text{time}$.
- 🔑 Cells, storage battery, generators, dynamos, solar cells are some of the sources of electric current.
- 🔑 Two Italian scientists Galvani and Volta invented electric cells.
- 🔑 A cell is a device for giving a continuous supply of current. It consists of an electrolyte in which two electrodes of suitable substances are dipped.
- 🔑 Voltaic cell, Daniel cell and dry cells are also called primary cells because they can not be recharged.
- 🔑 Rechargeable cells are called storage cells or accumulators or secondary cells.
- 🔑 Any source of electricity involves the transformation of some form of energy into electrical energy.
- 🔑 Substances which allow electricity to flow through them are called conductors.
- 🔑 The path along which the current flows is called a circuit.
- 🔑 Electricity can flow only, if the circuit is closed or complete.
- 🔑 A circuit diagram shows how various circuit components are connected.
- 🔑 An electric fuse is a short piece of wire of low melting point.
- 🔑 Electricity can be very dangerous and may cause electric shock, deaths, accidents and fires, etc.

- 🔑 Loose connections, defective switches, improper wiring and earthing are some causes which make electricity hazardous.
- 🔑 We must take the necessary precautions while handling any electrical circuit or electrical appliance at home.
- 🔑 The unit of electricity usage is the kilowatt hour (kWh) which is one kilowatt used for one hour.
- 🔑 Electricity meters record the number of units of electricity (kWh) that we use. We are charged per unit.

KEY WORDS

Surplus:	an excess of production or supply.
Terminal:	finishing point or end point.
Anode:	positively charged electrode.
Cathode:	negatively charged electrode.
Arsenic:	a grey and brittle metalloid.
Transform:	to change the appearance, to convert.
Exceed:	to be greater in number or size.
Deficit:	deficiency.
Electroscope:	an instrument for the detection of charge.
Electrode:	a conductor through which electricity passes.
Electrolyte:	a solution that can conduct electricity.
Induction:	the act of producing something.
Nuclear fission:	breaking of nuclei of a radioactive element which releases energy.
Mica:	a kind of mineral stone.
Appliance:	instrument.

**TEST YOUR KNOWLEDGE****A. Answer these questions.**

1. What is an electric current?
2. What is the direction of flow of electrons?
3. Who designed the first electric cell and when? Describe the construction of this cell.
4. Draw neat labelled diagrams of Voltaic cell, Daniel cell and Dry cell.
5. Write two advantages of a dry cell over a wet cell.
6. What is the main difference between a primary cell and a secondary cell?
7. Define a generator. Explain the principle on which a generator works.
8. Write a short note on storage cells and their types.
9. Define conductors and insulators? Give two examples of each.
10. What is an electric circuit? What is meant by open and closed circuit?
11. What is a fuse and what substance is used to make it? Write four safety measures to be taken while working with live electric lines.
12. Briefly explain the working of a hydro-electric power plant.

B. Fill in the following blanks:

1. Rechargeable cells are also called
2. Electricity is the flow of
3. Primary cells are
4. Secondary cells are also called
5. What is the unit of
6. In a dry cell energy is converted into energy.
7. Energy transfer is measured in
8. Electrons flow from.....to terminal of the battery.
9. A.....is a device for giving a continuous supply of current.
10. The unit of electricity usage is.....

C. Decide whether the following statements are TRUE/FALSE:

1. A dry cell is an improved form of the Leclanche cell.
2. Wood and rubber are insulators of electricity.
3. Light energy is converted into electrical energy in a primary cell.
4. An alloy having high a melting point is used to make fuse wire.
5. A thermal power plant is more costly than a hydro-electric power plant.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Choose the most appropriate answer:

1. Which of the following cells are recharged when run down?
a. Dry cell b. Voltaic cell c. Lead storage cell d. Daniel cell
2. A safety fuse must be connected in series with:
a. Live wire b. Earth wire c. Neutral wire d. All
3. The voltage of a single lead accumulator cell is:
a. 0.5 V b. 1 V c. 1.5 V d. 2 V
4. The potential difference is measured by a:
a. Voltmeter b. Altimeter c. Ammeter d. None
5. In dry cells, the chemical energy is transformed into:
a. Potential energy b. Kinetic energy c. Light energy d. Electrical energy

Homework Assignment

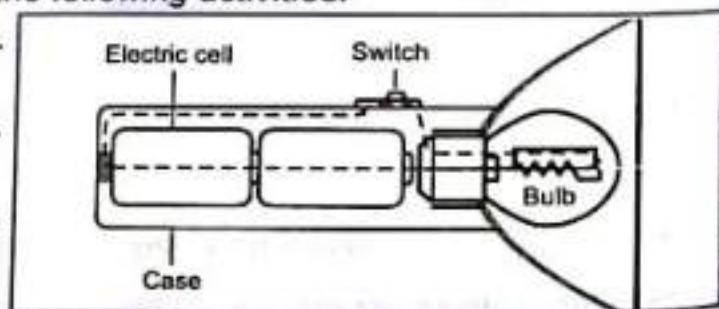


Search and study to write a note on alternative energy. Explain in your note what is alternative energy and why it is needed. List sources of obtaining alternative energy.

FUN WITH SCIENCE

To investigate an electric torch. Open it from either end and see what is inside. You will find that the torch has a small bulb and one more cylindrical objects called electric cells. These are enclosed in a metal or plastic case, with a switch on its side. Assemble the torch again and perform the following activities.

- (a) Push the switch to the 'on' position. What happens to the bulb?
- (b) Push the switch to the 'off' position. What happens to the bulb now?
- (c) Open the case and remove the cells. Now push the switch to the 'on' position. Does the bulb light up?



Formative Assessment - III (Based on Units 9-12)

Max. Marks: 25

Time: 30 minutes

A. Short - answer Questions

(12 Marks)

1. Explain why diamond is the hardest known substance.
2. Explain two reasons why synthetic fibres are not preferred over natural fibres.
3. A nail with a pointed end can more easily be fixed than a nail with a flat end. Explain why.
4. Why do we add manganese dioxide in a dry cell?
5. What do you understand by the term "allotropy"?
6. Define saponification and write its equation.

B. Complete the following table of hydrocarbons:

(02 Marks)

Name	Formula	State at normal temperature
Methane		
Ethane		
Propane		
Butane		

C. Group Activity

1. Visit the science laboratory to prepare glass by using sand, sodium carbonate and limestone.

(02 Marks)

2. Give one - word answers of the following questions:

(04 Marks)

1. What is the S.I unit of potential difference?
2. Which principle is used in the working of a hydraulic jack?
3. Name any one example of an organic fertilizer.
4. Which process is used in the preparation of charcoal?
5. Which unit is used to charge our electricity usage?
6. Who conducted the Magdeburg hemispheres experiment?
7. Which synthetic materials are called "soapless soaps"?

8. Which chemical compound is also known as "soda ash"?

E. Multiple Choice Questions

(05 Marks)

1. Which of the following is not related to diamonds?

- | | |
|-----------------------------|------------------------------|
| (a) Hardest known substance | (b) Bad conductor of heat |
| (c) Allotrope of carbon | (d) Amorphous form of carbon |

2. Pick out the synthetic material from the following:

- | | | | |
|---------------|------------|-----------|----------|
| (a) Cashmilon | (b) Cotton | (c) Linen | (d) Silk |
|---------------|------------|-----------|----------|

3. It is the correct value of atmospheric pressure at sea level:

- | | | | |
|----------------------|-----------------------|---------------|-----------------|
| (a) 76 cm of mercury | (b) 0.76 m of mercury | (c) 101325 Pa | (d) All of them |
|----------------------|-----------------------|---------------|-----------------|

4. Pick out the insulator from the following options:

- | | | | |
|---------------|---------------|--------------|-------------|
| (a) Moist air | (b) Tap water | (c) Charcoal | (d) Ebonite |
|---------------|---------------|--------------|-------------|

5. Solution of sodium hydroxide in water is also called:

- | | | | |
|--------------|---------|-------------------|-------------------|
| (a) Glycerol | (b) Lye | (c) Ordinary soap | (d) Soapless soap |
|--------------|---------|-------------------|-------------------|

6. It is the main component of natural gas:

- | | | | |
|-------------|------------|------------|-----------------|
| (a) Methane | (b) Ethane | (c) Butane | (d) All of them |
|-------------|------------|------------|-----------------|

7. Rise of every 10 meters decreases the mercury level by:

- | | | | |
|----------|----------|---------|------------------|
| (a) 1 mm | (b) 1 cm | (c) 1 m | (d) None of them |
|----------|----------|---------|------------------|

8. It is not a component of a dry cell:

- | | |
|-----------------------|-----------------------|
| (a) Copper sulphate | (b) Ammonium chloride |
| (c) Manganese dioxide | (d) Carbon |

9. The working principle of a generator was discovered by:

- | | |
|-------------------|----------------------|
| (a) Pascal | (b) Michael Faraday |
| (c) Luigi Galvani | (d) Alessandro Volta |

10. It is the main component of LPG:

- | | | | |
|-------------|------------|-------------|------------|
| (a) Methane | (b) Ethane | (c) Propane | (d) Butane |
|-------------|------------|-------------|------------|

Unit 13 Light and its Behaviour

Learning Objectives

At the end of this unit, students should be able to:

- understand and explain the speed of light and its unit.
- understand and define refraction of light.
- understand and explain laws of refraction.
- understand and explain refraction through a glass slab.
- understand and explain refraction through a prism.
- understand and explain dispersion of light.
- understand refraction through lenses.
- understand and define real and virtual image.
- understand and define various terms related to lenses.
- draw a ray diagram for position of images formed by lens.
- give examples of different optical instruments in which lenses are used.

You have already learnt some facts about light. You have learnt that light is a form of energy and it travels in straight lines. You have also learnt about eclipses, reflection of light and uses of plane and spherical mirrors. In this unit, you will learn some more facts about light. You will see what happens to a ray of light when it travels from one medium to another.

SPEED OF LIGHT IN DIFFERENT MEDIUMS

Light seems to travel from one place to another very rapidly in a straight line. The room seems to brighten up instantly when a lamp is lighted. This suggests that light travels with a very high speed. Scientists have found that the speed of light in air or vacuum is about 300,000 km/s. This is the highest speed that light can attain in any medium. In air, its speed is only marginally less, whereas in glass it is reduced to only about 200,000 km/s. In water, light travels at a speed of about 225,000 km/s.

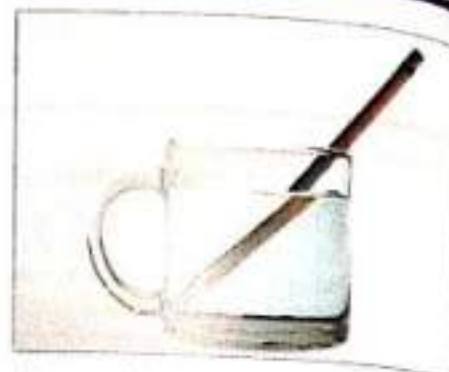
The speed of light in water is less in comparison with its speed in air. We say that water is **optically denser** than air or air is **optically rarer** (lighter) than water. Similarly, since the speed of light is less in glass than in water, glass is optically denser than water or water is optically rarer (lighter) than glass.

Optical density is a property of a transparent material; it is a measure of the speed of light through the material. The speed of light decreases in a denser medium while it increases in a rarer medium.

REFRACTION OF LIGHT

The phenomenon of refraction takes place when the light passes from one transparent medium to another. When light rays pass from one medium to another medium, they change their direction and this change in direction of light rays is called refraction of light.

Look at the pencil in this photograph. We know the pencil is straight, but it looks bent. Our eyes are being tricked into seeing something that is not true. This happens because light travels more slowly through the water than it does through the air. As a result, when the rays cross the **boundary** between the water and the air, they change direction. This change in direction is called **refraction**. We say that the rays have been **refracted**.



Let us understand the effect of the change of medium on the direction of propagation of light by performing the following activities.

ACTIVITY TIME! To show refraction of light in water.

Take an empty cup or beaker and place a coin at its bottom. Now, position yourself such that the coin is just not visible and is obstructed by the edge of the cup (Fig. 13.1). Now, ask someone to gradually pour water into the cup without disturbing the coin. What do you observe? You will observe that as the water level rises, the coin appears in sight.

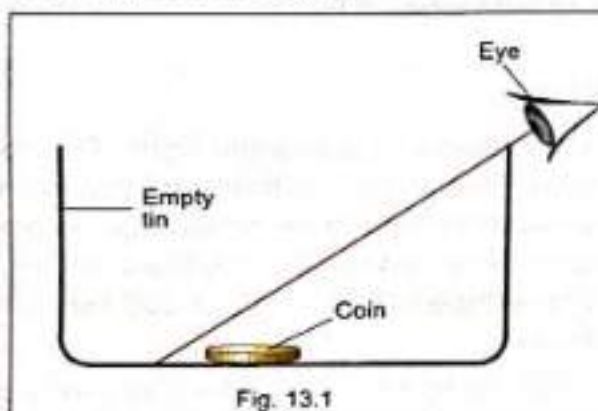


Fig. 13.1

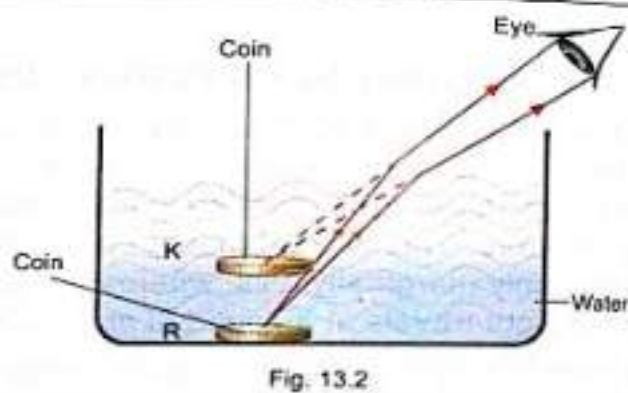


Fig. 13.2

You know that you can see an object because rays of light from the object reach your eyes.

When the coin is not visible to you, the rays of light travelling in a straight line do not enter your eyes (Fig. 13.1). As soon as water is poured in the cup, the rays change the direction and you can see the coin.

Fig. 13.2 shows you what happens to two rays of light when they leave the water and enter air- they change directions. They now appear to be coming from position K instead of R. The coin, thus, appears to be raised to K and becomes visible to you.

Therefore, we observe in the above activity that the light travelling in a straight line in a particular medium bends as soon as it enters another medium of a different density.

Good to know

Normal is a line drawn perpendicular to the surface of the second medium at the point where the light rays strike the surface of the second medium. It makes a 90° angle with the surface.

There is, however, no change of direction when the light rays pass through normal (i.e. in a direction perpendicular to the surface) into the other medium. (Fig. 13.3).

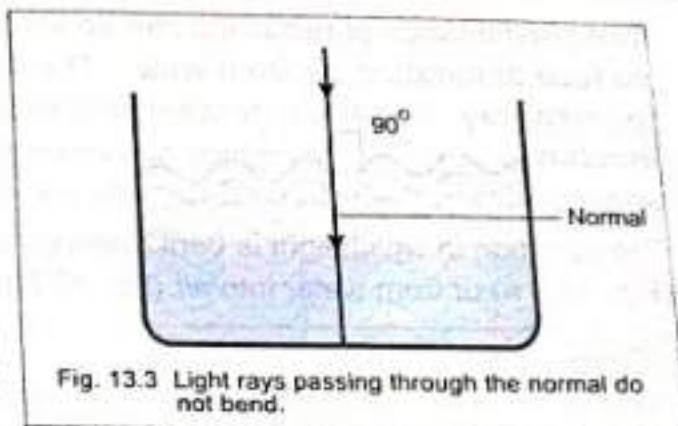


Fig. 13.3 Light rays passing through the normal do not bend.

REFRACTIVE INDEX

The speed of light in different substances varies, therefore, different substances have different abilities to bend or refract light. This bending ability of a material is called its **index of refraction or refractive index**. Refractive index is the ratio of the speed of light in vacuum to that in the medium and is denoted by μ .

$$\mu = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in the medium}}$$

Refractive index has no unit. The refractive indices of some substances with respect to air are given in Table 13.1.

Table 13.1. Refractive indices of some substances

Substance	Refractive index
Water	1.33
Glass	1.5 to 1.9
Glycerine	1.47
Ice	1.31
Kerosene oil	1.39
Turpentine oil	1.47

Among the most refracting substances are water, alcohol, ether and diamond. Gases in general are less refractive than water.

LAWS OF REFRACTION

There are two laws of refraction of light:

- The incident ray, the refracted ray and the normal to the surface of the point of incidence all lie in the same plane.
- The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant and is equal to the refractive index of the second medium with respect to the first medium. This is called the **Snell's law of refraction**.



Fig. 13.4 Willebrord Snell

The phenomenon of refraction can be studied by the ray diagram. In Fig. 13.5, (AB) is the surface separating air from water. The ray of light falling on the surface is called the **incident ray**. The angle between the incident ray and the normal is called the **angle of incidence** ($\angle i$). The ray which has changed its direction is called the **refracted ray**. The angle between the refracted ray and the normal is called the **angle of refraction** ($\angle r$). The direction in which light is bent depends upon whether the light travels from air into water (Fig. 13.5 a) or from water into air (Fig. 13.5 b).

Good to know

Willebrod Snell (1580-1626) was a Dutch mathematician who discovered and explained the phenomenon of refraction of light. The laws of refraction were his most important contribution to science, although they were not published until almost 70 years after his death.

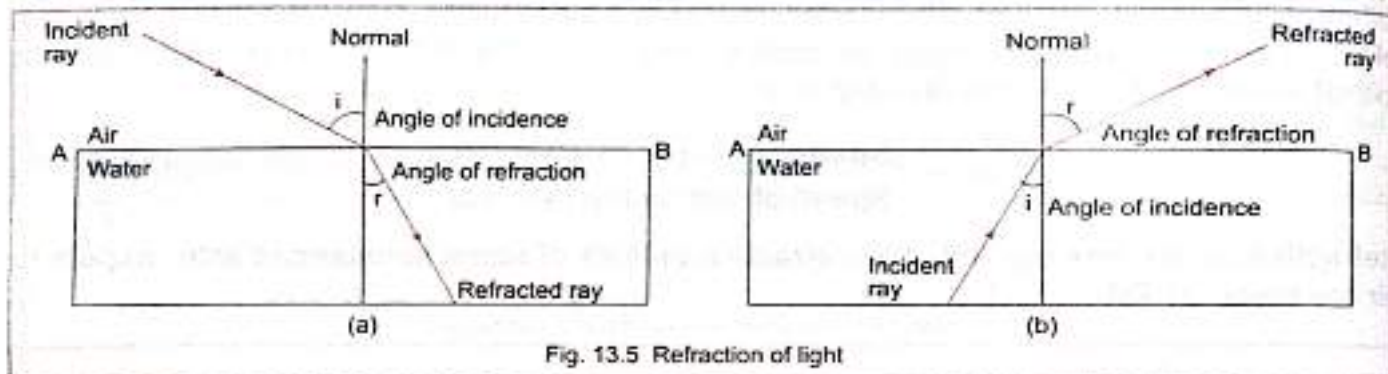


Fig. 13.5 Refraction of light

When a ray of light travels from air into water, it bends towards the normal as shown in Fig. 13.4 (a). Instead of going straight, the ray of light moves closer to the normal. The angle of refraction ($\angle r$) is less than the angle of incidence ($\angle i$). On the other hand if a ray of light travels from water into air, it bends away from the normal as shown in Fig. 13.4 (b). Instead of going straight, the ray moves further away from the normal. The angle of refraction ($\angle r$) is more than the angle of incidence ($\angle i$).

Thus, we conclude that:

- If a ray of light travels from a rarer medium into a denser medium, it is refracted towards the normal at the point of incidence.
- If a ray of light travels from a denser medium into a rarer medium, it is refracted away from the normal at the point of incidence.
- When a ray of light falls normally on the surface separating two substances, it passes straight through without refraction (Fig. 13.3).

The refractive index of light can be calculated through following formula:

$$\frac{\sin i}{\sin r} = \mu$$

Refraction through a glass slab

ACTIVITY TIME! To show refraction of light through a glass slab.

Fix a sheet of white paper on the drawing board. Put the rectangular glass slab on it and mark the boundary ABCD with a pencil. Fix two pins P and Q on the longer side of the slab so that the pins are vertical and the line passing through PQ meets the slab obliquely. Look for the images of the two pins from the opposite side. Fix a pin R so that it covers the images of the first two pins P and Q; and the images of the first two pins and the pin R appear to be in a straight line. Fix another pin S covering the images of the first two pins and the third pin R (Fig. 13.6).

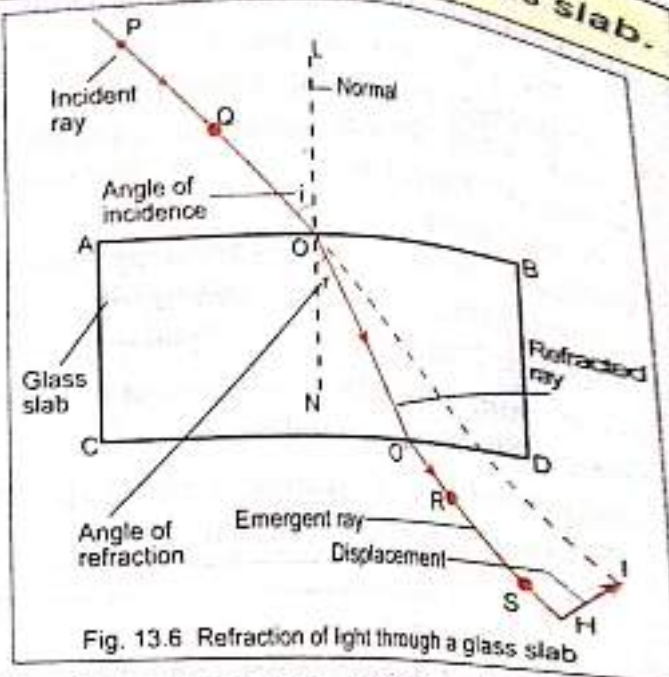


Fig. 13.6 Refraction of light through a glass slab

Mark the positions of the pins. Remove the pins and the slab. Join PQ and extend it to meet the slab boundary at O. The PQ is the incident ray. Join SR and extend it to meet DC at O'. Then RS is the emergent ray. Join O to O'. OO' is the refracted ray. Draw the normal NOL to the surface.

Now, measure the angle of incidence ($\angle i$) and the angle of refraction ($\angle r$). You will observe that $m\angle r$ is less than $m\angle i$. Can you account for this difference?

Refraction through a prism

A prism is a wedge-shaped block of glass as shown in Fig. 13.7. Two plane surfaces through which a light ray is passed are called the **refracting faces of the prism** and the angle between them is known as the **refracting angle of the prism**. The face opposite to the angle of the prism is called the **base of the prism**. When a ray of light passes through a prism, it splits into its component lights and this phenomenon of splitting of white light into different colored lights is called **dispersion of light**.

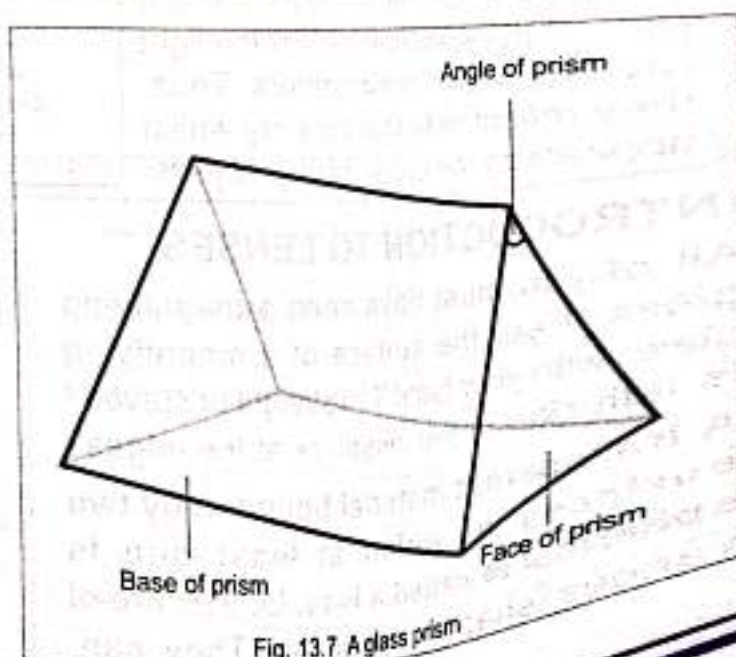


Fig. 13.7 A glass prism

ACTIVITY TIME! To show dispersion of light through a prism.

Allow a very narrow beam of white light to fall on one face of a prism. Hold a white screen on the other side so that light emerging out of the other face falls on it (Fig. 13.8). What do you observe on the screen? You will see that the light has split up into different colours on the screen. You will see seven colours in the following order: violet, indigo, blue, green, yellow, orange and red. These colours can be remembered by a word **VIBGYOR**. Violet is most deviated and red is least deviated. These colours resemble those of a rainbow.

This band of seven colours is called **spectrum** of light. Thus, white light is a mixture of seven lights of different colours.

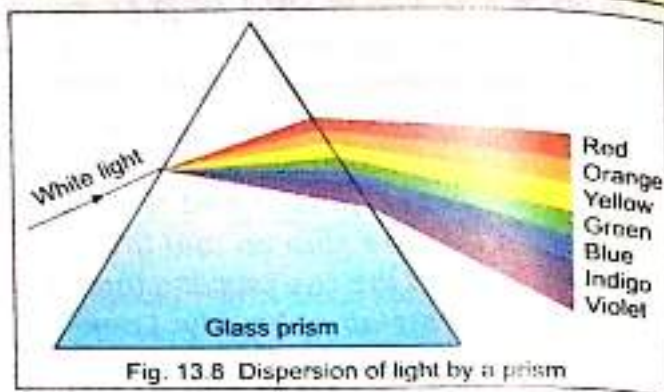


Fig. 13.8 Dispersion of light by a prism

Good to know

The rainbow is a very common example of dispersion of light in nature. How is it formed? After rain, tiny droplets of water remain suspended in the atmosphere. When the sun appears, the light gets dispersed by refraction through these drops of water. As a result, rainbow appears in the sky, comprising of seven colours.

**Good to know**

Colored objects absorb all the light rays of the spectrum except the light ray that shows their colours. Thus, they reflect only this light ray which appears as the colour of their objects.

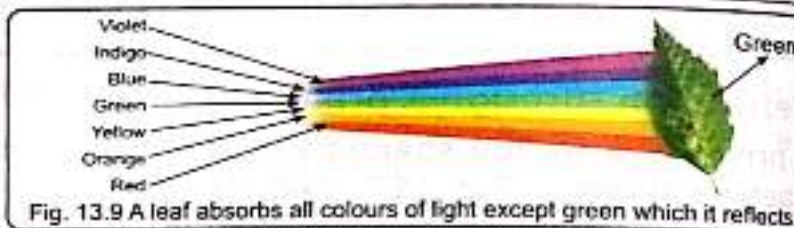


Fig. 13.9 A leaf absorbs all colours of light except green which it reflects.

INTRODUCTION TO LENSES

All of you must have seen a magnifying glass. Feel the surface of a magnifying glass with your hand. Is it straight or curved? Is it thicker in the middle or at the edges?

A transparent material bounded by two surfaces of which at least one is spherical is called a lens. Lenses are of various shapes and sizes. They can,

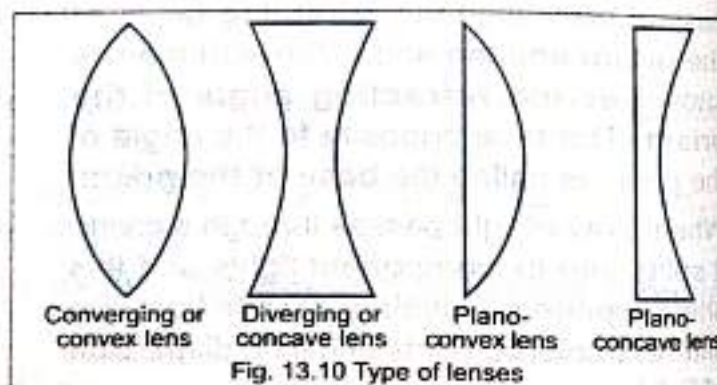


Fig. 13.10 Type of lenses

however, be classified into two types: converging (or convex) lens, and diverging (or concave) lens.

A **converging (convex) lens** is thick in the middle and becomes thinner at the edges (Fig. 13.10). A **magnifying lens is a converging lens**. A converging lens bends a ray of light passing through it inwards.

A **diverging (concave) lens** is thin in the middle and thicker at the edges (Fig. 13.10). It has the property of bending a ray of light passing through it outwards.

Working of lenses

If you look at the shape of a converging lens, you will notice that it can be thought of as made up of a group of prisms or sections of prisms with a thin glass slab in the middle (Fig. 13.11). The prisms at the edges of the lens have the maximum refracting angle.

You have seen that a ray of light on passing through a prism bends towards its base. You have also seen that the extent of bending (or deviation) increases as the refracting angle of the prism increases.

Thus, in Figure 13.11, the rays of light 1 and 5, incident at the edges of the lens, are deviated the most towards the centre. The rays 2 and 4 are also deviated towards the centre but the deviation is less than that of rays 1 and 5. The ray 3, passing through the centre (glass slab), is not deviated at all. All the rays, after refraction, meet at point F (Fig. 13.11). Thus, we see that a converging lens converges a parallel beam of light so that all the rays meet at a point.

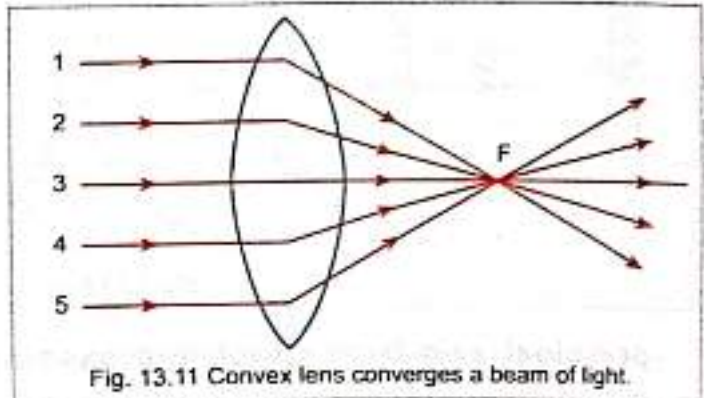


Fig. 13.11 Convex lens converges a beam of light.

Figure 13.12 shows the working of a diverging lens. The diverging lens can also be thought of as made up of a number of prisms or sections of prisms with a thin glass slab in the centre. However, in this case, their faces are in the opposite direction as compared to the prisms that make up a converging lens. Therefore, the rays of light are bent outwards.

If a parallel beam of light is incident on a diverging lens, its rays diverge from each other. When these rays are extended backwards, they appear to come from a central point.

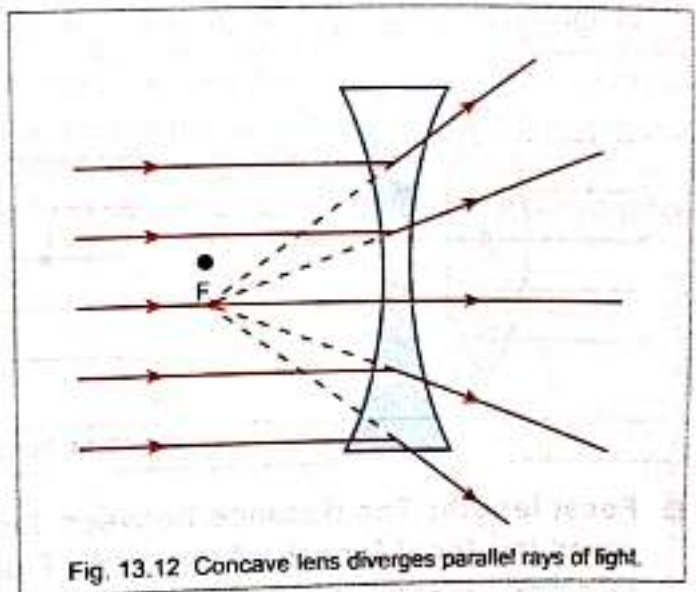


Fig. 13.12 Concave lens diverges parallel rays of light.

Terms related to lenses

- **Principal axis:** The line joining the centres of the two spheres (C_1 and C_2) from which the lens is made is called the principal axis of the lens (Fig. 13.13).
- **Optical centre:** We have seen that the central portion of a lens can be considered to be a thin glass slab. Therefore, a ray of light passing through the centre O is not deviated. It does undergo a little displacement. However, since the lens is thin, this displacement is very small and can be neglected. The point O is called the **optical centre** of the lens (Fig. 13.13). Thus, the **optical centre of a lens is a point on the**

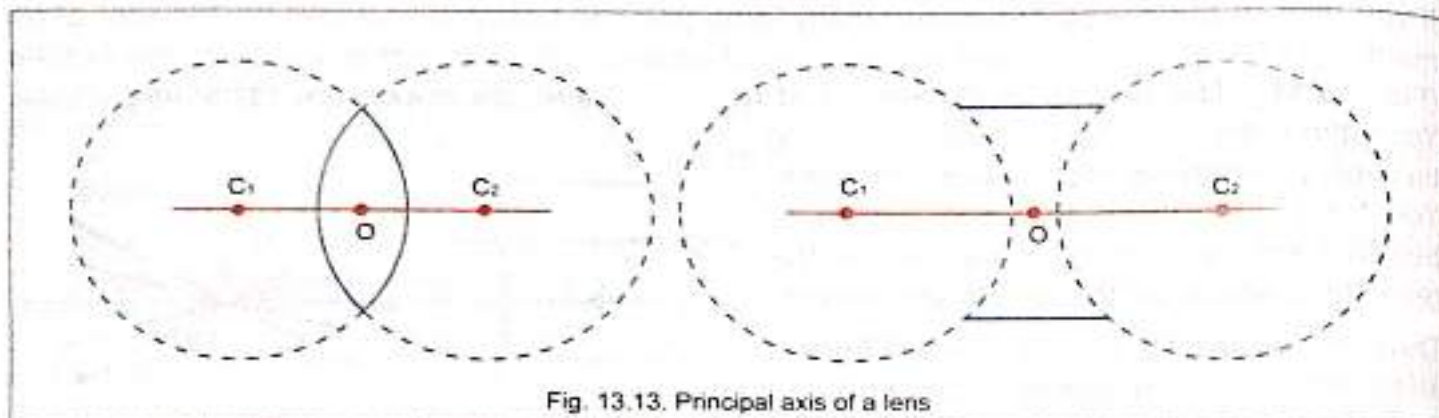


Fig. 13.13. Principal axis of a lens

principal axis from which the passing ray does not undergo any deviation.

- **Principal focus:** We have seen that if a beam of light parallel to the principal axis is incident on a converging lens, the rays of light after passing through the lens converge at a point F (Fig. 13.14 a). This point is called the **principal focus** or simply the **focus** of the lens. For a diverging lens, the focus is the point from where the rays of light, after passing through the lens, appear to come from (Fig. 13.14 b).

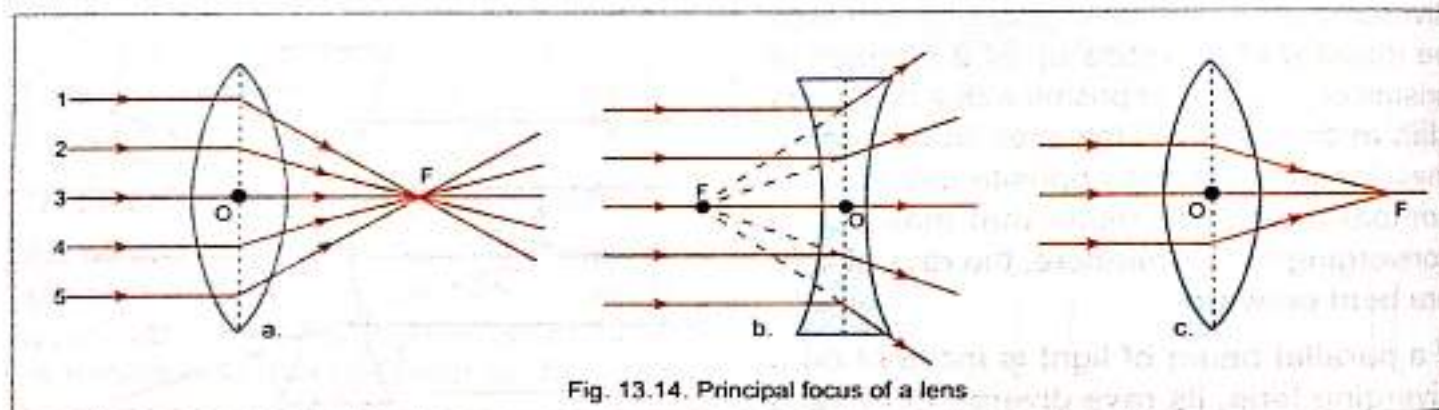


Fig. 13.14. Principal focus of a lens

- **Focal length:** The distance between the optical centre and the focus of a lens is called the **focal length** of the lens. The thicker the lens, the more it bends light rays, and the smaller is its focal length (Fig. 13.14 a, c).

Power of a lens

It is defined as the reciprocal of the focal length of a lens (in meters). Thus, the power P is

$$P \text{ (diopter)} = \frac{1}{f \text{ (meter)}}$$

It is expressed in **dioptries**. A diopter is the power of a lens whose focal length is 1 meter. Its value is positive for a convex lens and negative for a concave lens.

Images formed by lenses

A lens can form either a real image or virtual image.

REAL IMAGE

When two or more rays starting from a point on the object, after refraction through the lens, actually meet at point, its real image is said to be formed. A real image can be obtained on a screen. It is always inverted.

VIRTUAL IMAGE

When two or more rays starting from a point on the object, after refraction through lens, do not actually meet but appear to meet from a point on the side of the object, the virtual image is said to be formed. It can not be obtained on a screen. It is always erect and formed on the same side of the lens on which the object is situated.

Tracking light rays in a lens

To locate the image formed by a lens, we have to trace the paths of any two rays coming from a point on the object after they are refracted by the lens. The point at which the rays meet or appear to come from is the image. For convenience, we take any two of the following rays:

- ▣ **A ray parallel to the principal axis:** This will pass through the focus in a converging lens (Fig. 13.16 a). In case of a diverging lens, it will appear to come from the focus.
- ▣ **A ray passing through the optical centre:** This will emerge undeviated in a converging lens (Fig. 13.16 b).

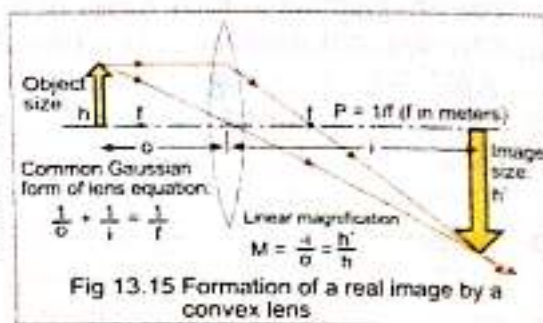


Fig 13.15 Formation of a real image by a convex lens

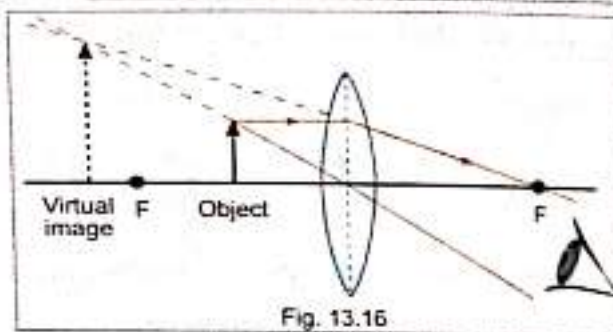


Fig. 13.16

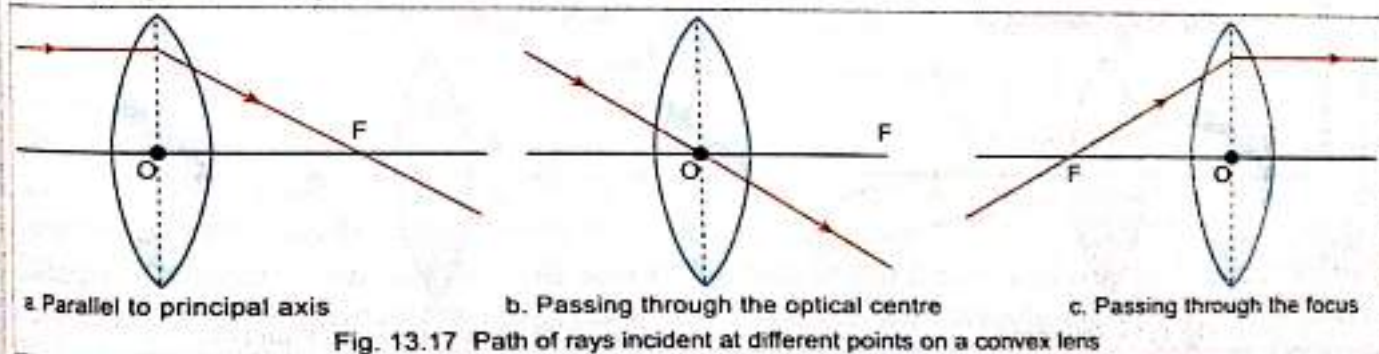


Fig. 13.17 Path of rays incident at different points on a convex lens

- **A ray passing through the focus:** This will emerge parallel to the principal axis in a converging lens (Fig. 13.16 c).

IMAGES FORMED BY A CONVEX LENS: The image formed by a convex lens varies in size, position and nature (erect or inverted, real or virtual) depending upon the distance of the object from the lens.

- **Object very far off:** The rays of light coming from an object that is very far off (like the sun) are parallel to each other. We have already seen that if the rays are parallel to the principal axis, they meet at the focus. Thus, the image is formed at the focus. If the rays are not parallel to the principal axis, it is clear from Figure 13.18 that the image is still formed at the focus. It is real, inverted and smaller than the object.
- **Object beyond $2F$:** The image formed is between F and $2F$ on the other side of the lens. It is real, inverted and smaller than the object (Fig. 13.19). Being a real image it can be formed on a screen placed at that point.
- **Object at $2F$:** The image is real, inverted and of the same size as the object. It is located at $2F$ on the other side of the lens (Fig. 13.20).
- **Object between F and $2F$:** The image is real, inverted and larger than the object. It is situated beyond $2F$ on the other side of the lens (Fig. 13.21).

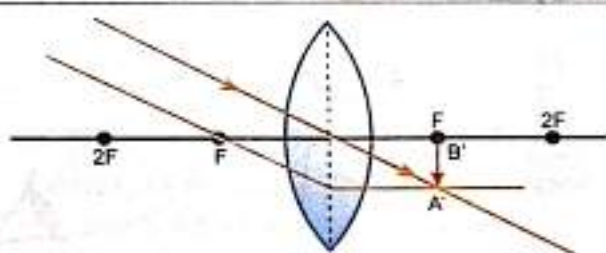
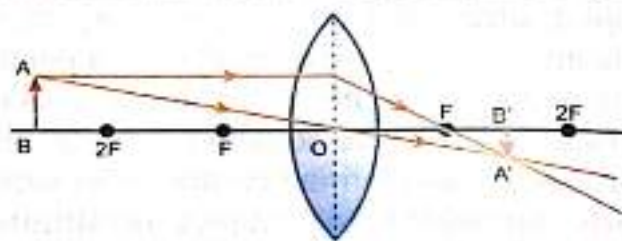
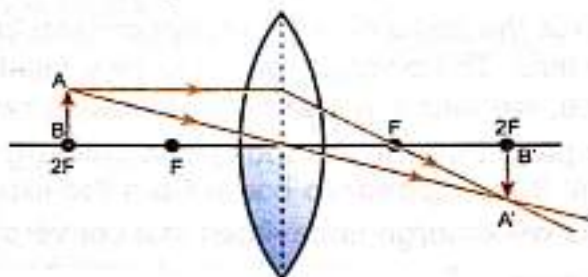
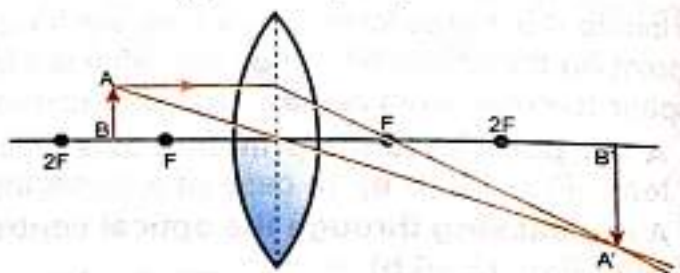
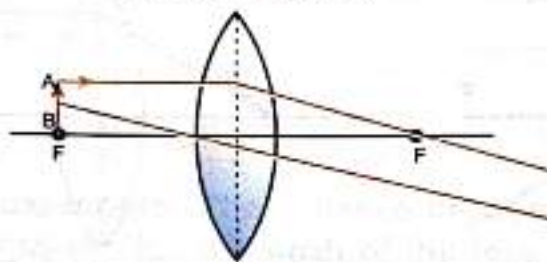
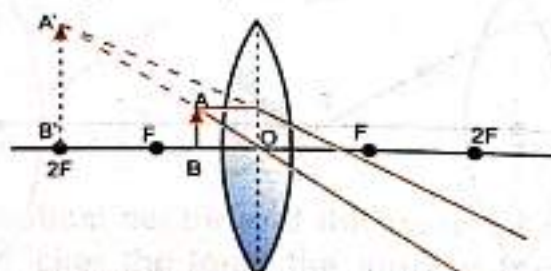


Fig. 13.18 Object very far-off

Fig. 13.19 Object beyond $2F$ Fig. 13.20 Object at $2F$ Fig. 13.21 Object between F and $2F$ Fig. 13.22 Object at F Fig. 13.23 Object between F and O

- Object at F: In this case, the refracted rays emerge parallel to each other. Therefore, no image is formed as the rays do not meet (Fig. 13.22). However, since parallel rays are assumed to meet at infinity, we say that the image is formed at infinity. It is real, inverted image, very much bigger in size than the object.
- Object between F and O: If you draw the two rays, in this case you will find that the rays diverge after refraction. Thus, a real image is not formed in this case. If the divergent rays are extended backwards, they meet at a point. Thus, the rays appear to come from this point. The image is, therefore, virtual. It is erect, bigger than the object and is formed on the same side of the lens as the object (Fig. 13.23). This position of the object is used when a convex lens is used as a magnifying glass.

The nature, size and location of the image formed by a convex lens for different positions of an object are summarised in Table 13.2.

Table 13.2. Position, nature and size of the image formed by a convex lens

Position of the object	Position of the image	Nature of the image	Size of the image
beyond 2F	between F and 2F	real and inverted	smaller than the object
at 2F	at 2F	real and inverted	same size as the object
between F and 2F	beyond 2F	real and inverted	larger than the object
at F	at infinity	real and inverted	very larger than the object
between F and O	on the same side as the object	virtual and erect	larger than the object

ACTIVITY TIME! To find the approximate focal length of a convex lens. (magnifying glass)

Hold the magnifying glass in one hand with one of its convex surfaces facing the sun. Hold a white cardboard sheet in your other hand, and keep it at some distance away on the other side of the lens (Fig. 13.24). You will see sunlight falling on the cardboard after passing through the lens. Move the lens backwards and forwards, until a small, sharp image of the sun is formed on the cardboard. Recall that the image of a distant object like the sun is formed at the focus of the lens. Therefore, the distance from the lens to the cardboard now gives the approximate focal length of the lens.

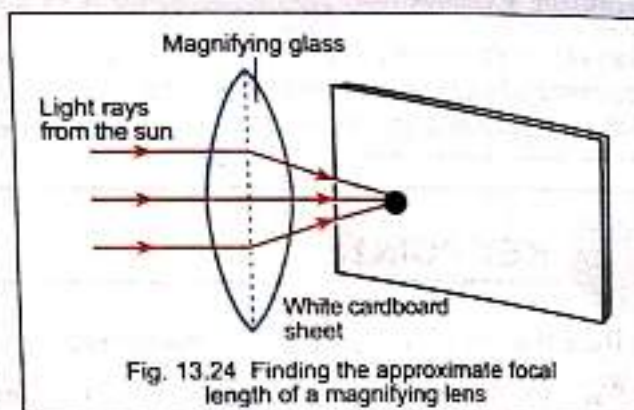


Fig. 13.24 Finding the approximate focal length of a magnifying lens

At this point, the cardboard may start smouldering after a few seconds. This is because the lens concentrates the rays of the sun over a very small area, making the area very hot.

IMAGE FORMED BY A CONCAVE LENS:

The rays falling on a concave lens, after refraction, always diverge. Therefore, no matter where the object is kept, a diverging lens always forms a virtual image, which is erect and smaller in size than the object. It is formed between the optical centre and the focus, on the same side of the lens as the object (Fig. 13.25).

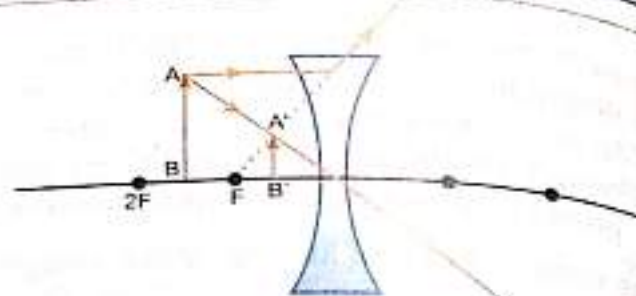


Fig. 13.25 Image formed by a concave lens

OPTICAL INSTRUMENTS

Lenses are used in several optical instruments such as cameras, microscopes, telescopes, slide projectors and binoculars. The eye is a natural optical instrument. It enables us to see things around us by forming their images on a screen called the RETINA.



Amazing facts!

Our eyes have a biconvex lens inside that forms the real and inverted image on retina. This image is sent to the brain which shows this image as upright. Cones and rods are sensory cells of retina that help to see colored light and dim light respectively. The retina has 107 million light sensitive cells.

Teacher's corner



Deliver a multimedia presentation to students about the working of lenses in different optical instruments.

Let's work in team!



Under the supervision of your teacher, construct a model of a camera/eyeball. Make a presentation to explain its working to the students of other classes.



KEY POINTS

Here is a list of key points to remember:

- 🔑 The velocity of light is different in different media.
- 🔑 In air or vacuum light travels at a speed of about 300,000 km/s.
- 🔑 The speed of light in other transparent substances is less than that in air. These

- substances are said to be optically denser than air.
- The bending of light ray when it passes from one transparent medium to another is called refraction of light.
- A ray of light bends towards the normal when it passes from a rarer medium to a denser medium, and bends away from the normal when it travels from a denser medium to a rarer medium.
- Refractive index is the ratio of the speed of light in vacuum to that in the medium and is denoted by μ .
- There are two laws of refraction.
- White light consists of seven colours which can be remembered by the word VIBGYOR.
- The band of seven colours is called spectrum. The red rays are least deviated and the violet is most deviated.
- The phenomenon of splitting up of white light into different colours is called dispersion of light.
- A lens is a transparent medium bound by two surfaces of which at least one is spherical.
- Lenses are of two types: convex or converging lenses and concave or diverging lenses.
- A convex lens forms virtual or real image depending on the position of the object.
- A concave lens forms only virtual images for all positions of the object.
- The power of a lens is the reciprocal of its focal length expressed in metres. The S.I unit of power of a lens is diopters.
- The position, size and nature of the image formed by a lens depends on the distance of the object from the lens and the focal length of the lens.
- Lenses are used in several optical instruments such as cameras, telescopes, microscopes, spectacles and binoculars.

KEY WORDS

- Propagation:** act of spreading.
- Medium:** way, path.
- Wedged:** sliced, segmented.
- Converge:** to meet at a point.
- Diverge:** to separate, split.
- Optical:** related to light and seeing.
- Incidence:** act of intersection of a line.
- Magnifying:** making something larger than it is.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. What is the speed of light in air, water and glass?
2. What is refraction of light? State the laws of refraction.
3. What do you mean by refractive index? Also write its formula.
4. What is the dispersion of light? Write the names of the seven colours which white light splits into.
5. What happens when the sunlight passes through a glass prism?
6. What is a lens? Name two types of lenses. What is meant by the power of lens?
7. Define the following terms:

(i) principal axis	(ii) principal focus
(iii) optical centre	(iv) focal length
8. What is the difference between a real image and a virtual image?
9. Draw the ray diagram of the images formed by convex lens: (a) when object lies between F and 2F, (b) when object lies at 2F
10. Draw ray diagrams to show the converging action of a convex lens and the diverging action of a concave lens.

B. Fill in the following blank:

1. A image can not be taken on a screen.
2. The separation of light into its various components is called
3. A converging lens is in the middle than at the edges.
4. A image cannot be obtained on a screen.
5. The speed of light in water is than in air.

C. Indicate whether the following statements are TRUE/FALSE by putting tick mark (✓) in the appropriate box.

- | | TRUE | FALSE |
|---|--------------------------|--------------------------|
| 1. A spectrum, formed by the dispersion of the sunlight, has seven colours. | ☐ | ☐ |
| 2. Coloured objects reflect all colours of light falling on them. | ☐ | ☐ |
| 3. A magnifying glass forms a virtual and inverted image. | ☐ | ☐ |
| 4. A concave lens can form only virtual image. | ☐ | ☐ |
| 5. Power of a lens is measured in diopters. | ☐ | ☐ |

Choose the most appropriate answer for the following statements:

A magnified virtual image is produced by:

- a. Concave lens b. Convex lens c. Plane mirror d. None

The image produced by a concave lens is:

- a. Always virtual and enlarged b. Always real.
c. Always virtual and diminished d. Sometimes real, sometimes virtual

The focal length of a convex lens is 20cm. Its power in diopters is:

- a. 0.2 b. 2 c. 0.5 d. 5

The refractive index of turpentine oil is:

- a. 1.33 b. 1.39 c. 1.47 d. 1.31

The bending of light when it passes from one medium to another is known as:

- a. Reflection b. Refraction c. Dispersion d. Accommodation

Homework Assignment

Search and study about optical illusions (mirages) in nature. Write a note on the role of refraction of light in mirage formation.

FUN WITH SCIENCE

Instructions

Things You'll Need:

- ☐ A clear, large drinking glass
- ☐ Water
- ☐ A room with white/light colored walls
- ☐ Small mirror that will fit into glass
- ☐ A flashlight

Step 1



Fill your glass about 3/4 with water.

Step 2



Put the mirror in the glass while carefully trying to position it so it stays angled at the bottom, facing slightly upwards.

Step 3



Darken the room a bit and focus the flashlight on the mirror that is submerged in the glass.

Step 4



Look around the room for your rainbow. Feel free to move the light which will cause the rainbow to shift. Allow the children to discuss their observations.

UNIT 14

Magnet and Magnetism

Learning Objectives

At the end of this unit, students should be able to:

- understand that magnet is an object that can attract the objects of iron, steel nickel and cobalt,
- recognize temporary and permanent magnets.
- understand that a magnet has a magnetic field around it.
- recognize that a current carrying conductor also has a magnetic field around it.
- understand simple working principles of an electric generator, motor, microphone, speaker and telephone.

DISCOVERY OF MAGNETS

Nearly 5,000 years ago, people of **Magnesia**, a province in Asia Minor, discovered that a particular rock could attract small pieces of iron towards it. This wonderful rock was called **Magnetite** after Magnesia, the place where magnetic iron ore was first discovered.

The term magnet is derived from magnetite, which is an ore of iron (Fe_2O_4). Chinese were also familiar with the attractive property of magnets. Sailors used magnets to navigate their ships especially during cloudy weather. They gave it a Chinese name meaning **leading stone**. This word gradually got changed to **lodestone**.

INTRODUCTION TO MAGNETS

Any substance which possesses the following two properties is called a **magnet**.

1. It attracts small pieces of iron, nickel and cobalt.
2. It always comes to rest in the north-south direction when suspended freely.

Magnet itself is made by iron, steel or cobalt. These substances are known as magnetic substances and others are known as non-magnetic substances. Magnets are found naturally. However, man made magnet is known as artificial magnet. Magnets have different shapes as given below (Fig. 14.1).



Fig. 14.1 shapes of magnets

TEMPORARY AND PERMANENT MAGNETS

Soft iron is easily magnetised. It is also easily demagnetised. Since soft iron loses its magnetism easily, magnets made from it are called **temporary magnets**.

Steel is not easily magnetised. Neither it is easily demagnetised.

Because steel retains its magnetism for a long period, magnets made from it are called **permanent magnets**.

PROPERTIES OF MAGNETS

William Gilbert of England was the first person to study and record the properties of a magnet in a book titled "**The Magnet**".

Let us now study some important properties of magnets.

1. Poles of a Magnet

A magnet has two poles i.e. North and South poles. The force of attraction of magnet is maximum at its poles.



Fig. 14.2 William Gilbert

ACTIVITY TIME! To show that the attraction of a magnet is greater at its pole

Spread out some iron filings over a sheet of paper. Now, move a bar magnet in the filings, taking care that all parts of the magnet touch the filings. Pick up the magnet and observe how the iron filings are distributed all over the magnet? You will notice that most of the iron filings cling near the ends of the magnet while there are very few iron filings near the middle (Fig. 14.3). These two ends of the magnet where the magnetic force is greatest are called the poles of the magnet. A bar magnet has two poles.

Repeat the experiment with a horse shoe magnet. You will find that it also has two poles at its ends (Fig. 14.3).

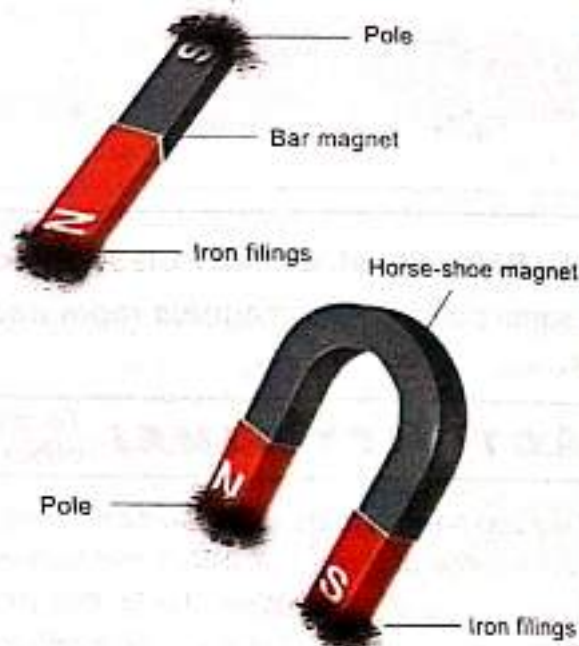


Fig. 14.3 The attraction of a magnet is greatest at the poles.

2. Directional Property

Magnet has a directional property i.e. when a magnet is suspended freely, it comes to rest in north-south direction.

ACTIVITY TIME! To show that a freely suspended or floating magnet points towards north-south direction.

Take a bar magnet and suspend it freely as shown in Fig. 14.4 or float it on a block of wood in water (Fig. 14.5). The magnet comes to rest after some time. Disturb it a little from its position of rest and see what happens. You will find that the magnet always comes to rest in the north-south direction.

The end of the magnet that points towards the north is called the North Pole (N-Pole) and the other end of the magnet pointing towards the south is called the South Pole (S-Pole).

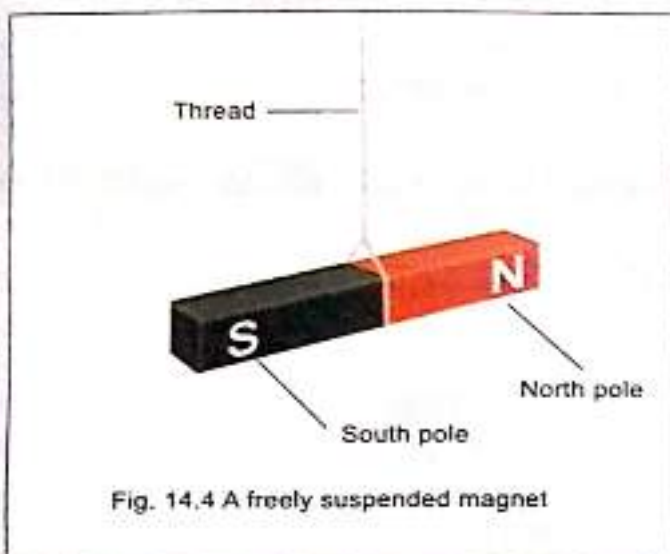


Fig. 14.4 A freely suspended magnet

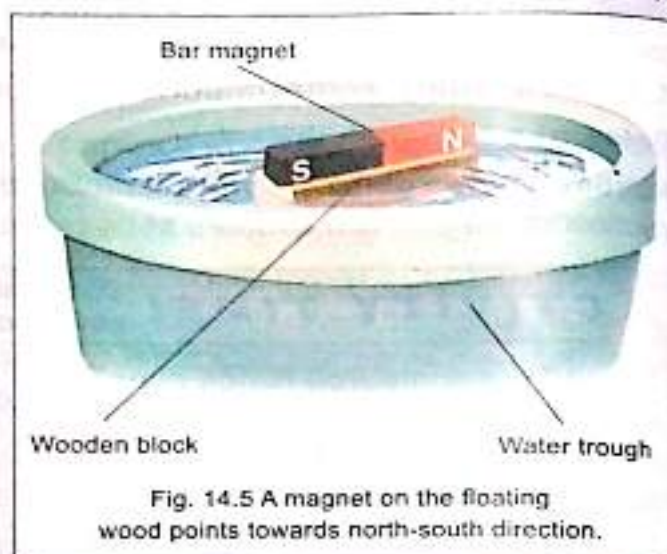


Fig. 14.5 A magnet on the floating wood points towards north-south direction.

3. Like Poles Repel, Unlike Poles Attract

The same poles of two magnets repel each other. However, opposite poles attract each other.

ACTIVITY TIME! To show that like poles of a magnet repel each other while unlike poles attract each other

Take two bar magnets. Suspend one magnet with a piece of thread. It will come to rest in the north-south direction. Hold the other magnet in your hand and bring its north pole near the north pole of the suspended magnet, as shown in Fig. 14.6. What do you see? You will find that the north pole of the suspended magnet is repelled.

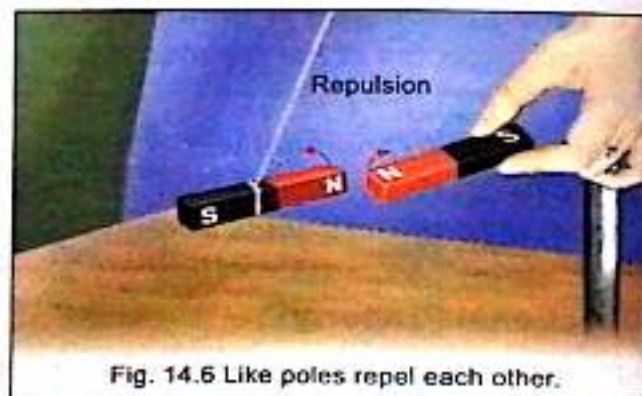


Fig. 14.6 Like poles repel each other.

Now bring the south pole of the magnet in the hand near the north pole of the suspended magnet. You will find that north pole of the suspended magnet will be attracted towards the south pole of the other magnet (Fig. 14.7).

We, therefore, conclude from this activity that in magnets, like poles repel and unlike poles attract each other.

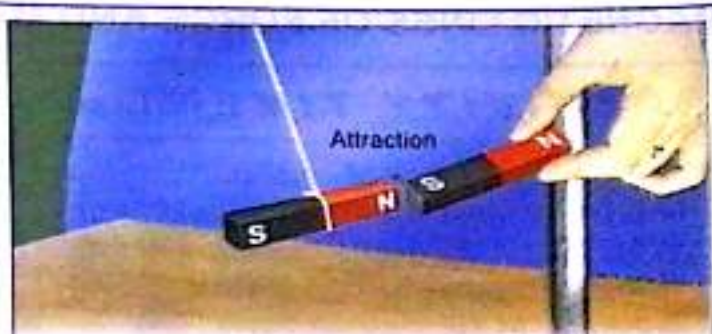


Fig. 14.7 Unlike poles attract each other.

1. Magnetic Poles always Exist in Pairs

If a bar magnet is broken into two pieces, you will see that each piece behaves as a whole magnet. This shows that new poles are formed at the broken ends as shown in Fig. 14.8. If these pieces are broken again, each smaller piece still remains a whole magnet with two opposite poles. Even a very small piece of a magnet is a whole magnet. Thus, we see that the smallest piece of a magnet has north and south poles and we can not break it into north and south poles separately.

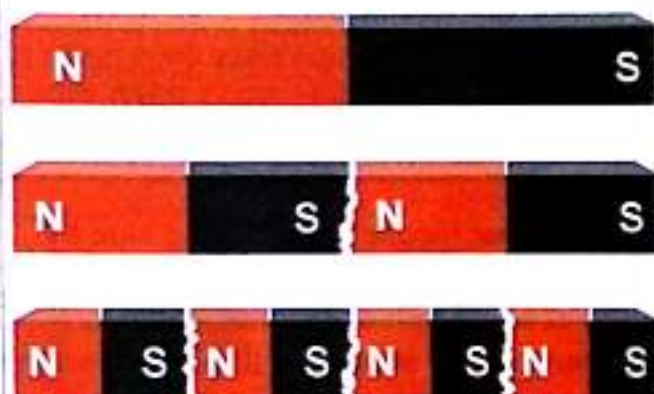


Fig. 14.8 Magnetic poles always exist in pairs.

We, therefore, conclude that magnetic poles always exist in pairs.

2. Magnetic Induction

The phenomenon by which an ordinary piece of iron temporarily acquires magnetic properties, due to the presence of another magnet near it, is called **magnetic induction**.

ACTIVITY TIME! To show magnetic induction.

Take some iron filings in a beaker. Fix an iron nail in a wooden stand over iron filings as shown in Fig. 14.9. Bring a magnet with its one pole close to the iron nail. What do you observe? What happens to the iron filings? You will find that iron nail starts attracting iron filings. This is due to the fact that the iron nail becomes magnetised by the magnet kept close to it. Now, remove the magnet, the iron filings fall down. This shows that as soon as the magnet is removed the nail loses its magnetism.

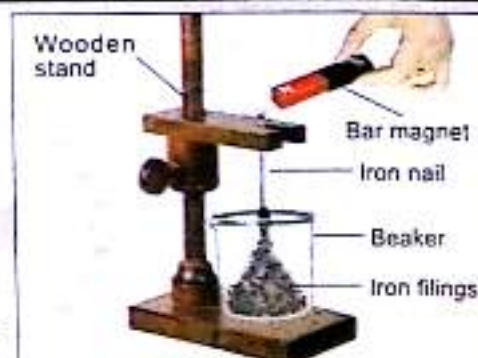


Fig. 14.9 Iron nail becomes an induced magnet.

UNIT - 14

MAGNETIC LINES OF FORCE AND MAGNETIC FIELD

ACTIVITY TIME! To show magnetic lines of force.

Place a white piece of cardboard on top of a bar magnet. Carefully sprinkle iron filings over it. By gentle tapping, the iron filings will arrange to form lines as shown in the Fig. 14.10.

These lines which are formed are known as the magnetic lines of force. The area in which these lines are formed is known as the magnetic field.

Magnetic lines of force pass from north to south and they never cross each other.



Fig. 14.10 Magnetic lines of force

When two bar magnets are placed side by side with their opposite poles (north and south) near each other, the iron filings form a pattern which shows the lines of force passing between the two poles. This shows the force of attraction between two opposite poles.

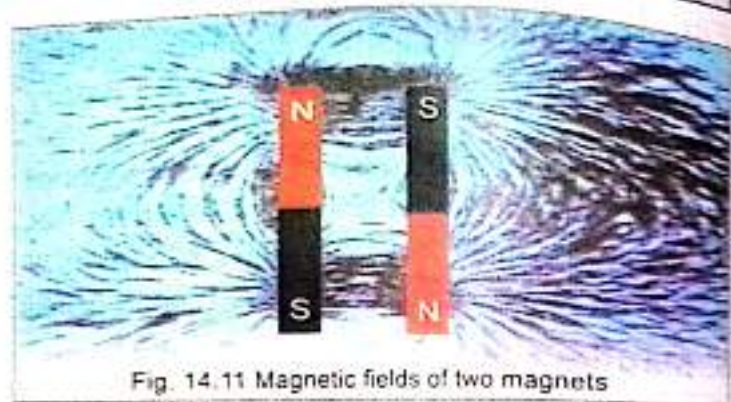


Fig. 14.11 Magnetic fields of two magnets

When two bar magnets are placed side by side with their like poles (the north poles or the south poles) near each other, the lines of force pass away from each other and swing at right angles away from the magnets. This shows the force of repulsion between two same (or like) poles. Between the poles there is a space where there is no magnetic field. This is known as the neutral point and is shown in Fig. 14.12 by point P.

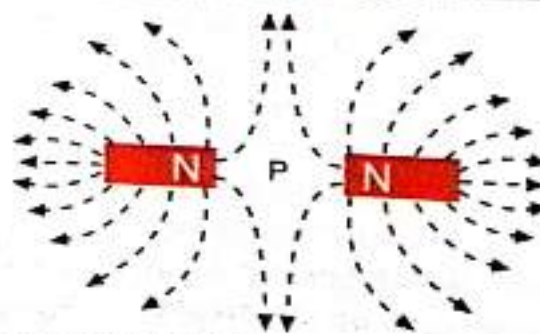


Fig. 14.12 Magnetic field between two like poles.



Fig. 14.13 Magnetic field of horse shoe magnet

When a horse shoe magnet is laid flat underneath a piece of paper on which iron fillings are sprinkled, a pattern is obtained. The lines of force appear crowded together between the poles because of their high intensity.

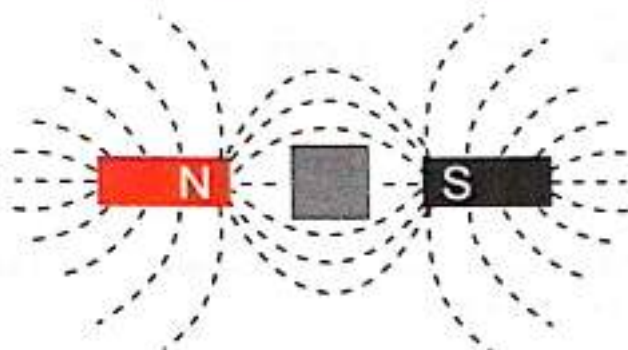


Fig. 14.14 Strong magnetic field caused by soft iron

A piece of soft iron, placed in the magnetic field, will bring the lines of force much closer together. This increases their intensities.

The area or region within which the effect of magnetic lines of force can be felt is called the **magnetic field**.

Characteristic of magnetic lines of force

The **magnetic lines of force**:

- travel from the north to the south pole of a magnet.
- do not divide into two or more lines.
- do not touch or cross over each other.
- repel each other sideways.
- become more crowded when a magnetic substance is placed in their path.

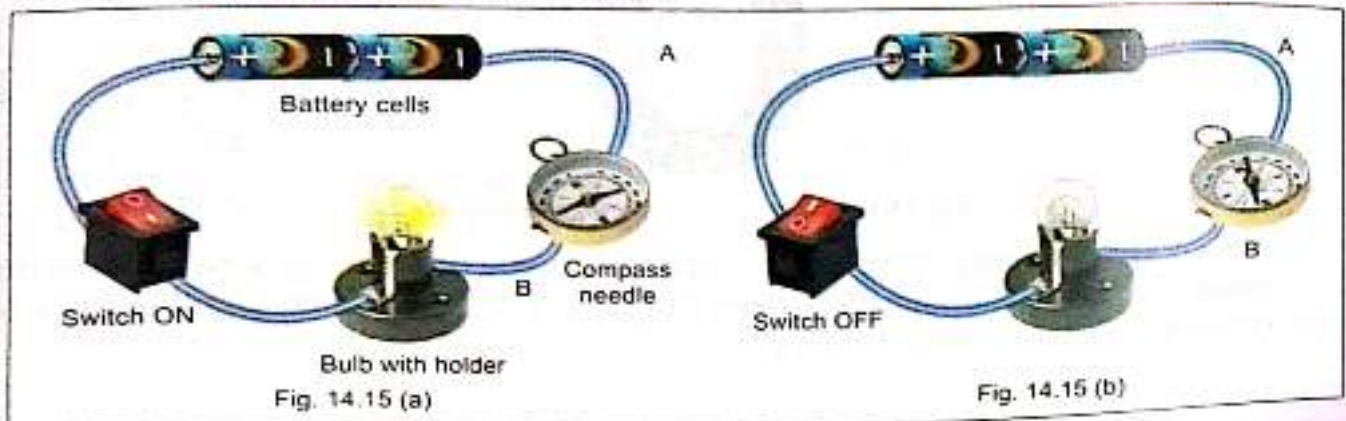
Relationship between current and magnetism

There is a strong relationship between electricity and magnetism. Following activity will

clarify this relationship.

ACTIVITY TIME! To show magnetic field of current.

Connect two battery cells, a compass needle, small bulb with holder, pieces of wire and a switch as shown in Fig. 14.15 (a).



Procedure:

Conductor AB lies in North-South direction. Place a compass needle on or near the conductor AB before turning the switch ON.

Do you observe the change in the direction of the compass needle?

Now turn the switch ON and again observe the needle placed on the wire. Do you observe the change in the direction now?

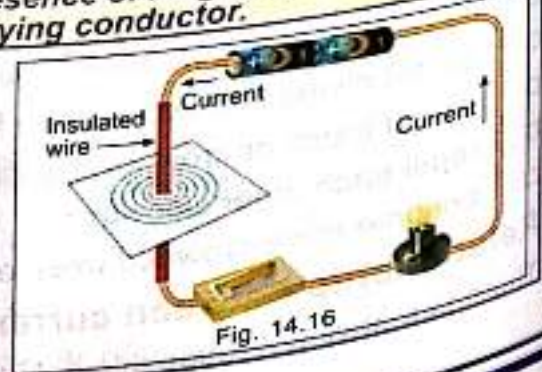
If yes, in which direction has the needle turned?

You can observe that the needle has now turned along East-West direction. This shows that when a current is passing through a wire, a magnetic field is produced around it i.e. which is indicated by the movement of the compass needle.

We find out from the above experiment that when a current is flowing through a wire or a conductor, a magnetic field is produced around it. Let us see now what is the shape of this field.

ACTIVITY TIME! To show the presence of magnetic field around the current-carrying conductor.

Make a hole in a cardboard and pass an insulated straight wire through it perpendicularly. Connect both ends of the wire to a battery of two cells, a bulb and a switch. Arrange the circuit as shown in Fig. 14.16. Sprinkle iron filings around the insulated vertical wire without turning the switch on, and tap the card slowly. Do iron filings assume a particular arrangement? Now turn the switch on card. Do



iron fillings assume some particular arrangement this time? You will see that the iron fillings will be arranged in concentric circles. These are the lines of the magnetic field. The lines of this field can also be drawn.

When the current passes through a straight wire, a magnetic field is produced around the wire in the form of concentric circles.

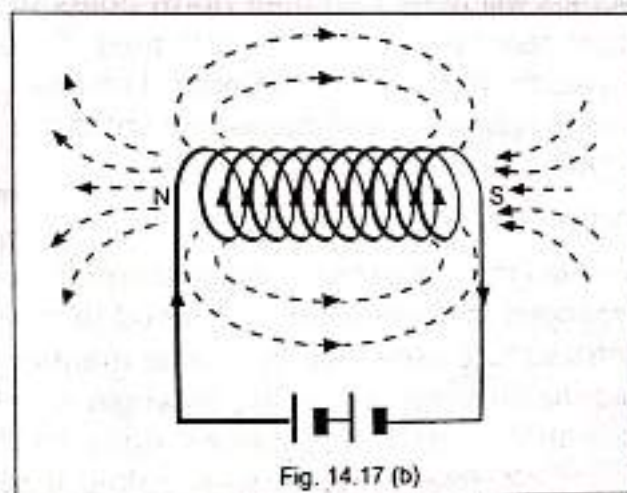
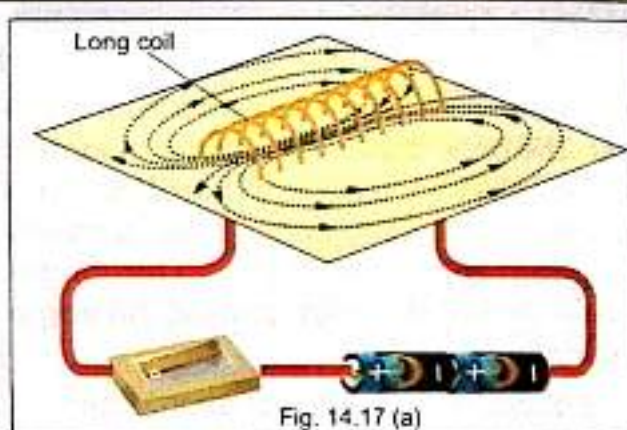
Observe carefully the magnetic lines of force formed by iron fillings. The circles of lines are close to one another near the wire which shows that the magnetic field is stronger near the wire. If the same experiment is performed with four cells instead of two, we will see that the magnetic field lines are even closer. From this, it is concluded that the force of magnetic field increases with increase in current in the conductor. The magnet which is produced by passing electric current through a conductor is called an **electromagnet**. If we use a long coil of wire instead of a straight wire and pass current through it, will the magnetic field be produced in this case? If it does, what will be its shape?

ACTIVITY TIME! To show magnetic field around a long electrified wire.

Take a coil of insulated wire about 4 inches long. Make a slit at the centre of a cardboard and place the wire in it, as shown in figure 14.17. Join the two ends of the coil to a battery of two cells and a switch. This will make an electromagnet. With the help of a magnetic compass needle, the lines of magnetic field can be drawn on the card by a pencil.

Put the magnetic compass needle at the middle of one end of the coil. Does the coil attract the north end of the needle towards it or repel it away? Will this end of the electromagnet be the north pole or south pole?

Now put the needle at the middle of the other end of the coil, observe which pole of the electromagnet is this? The end of coil which attracts the north end of needle will be the S-pole and the end of coil, which attracts the south end of the needle will be N-pole of the electromagnet.



Compare the field of the coil with that of a bar magnet.

Are both the fields similar? If yes, what characteristics make them so?

EARTH'S MAGNETISM

Since a freely suspended magnet always points in a definite direction, it must mean that the earth itself is a large magnet. The south pole of this magnet points almost towards the geographical north pole while its north pole points almost towards the geographical south pole. The magnetic poles, however, do not coincide with the geographic poles.

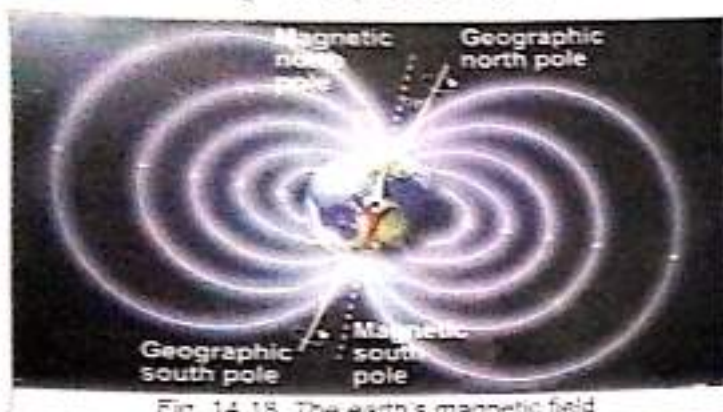


Fig. 14.18 The earth's magnetic field

They are a short distance away from each other. The circle drawn through the magnetic poles is called the **magnetic meridian**, and that through the geographic poles is called the **geographic meridian**. The angle between these two circles is called the **angle of variation**.

Since opposite poles attract each other, all magnets will point with their north poles to a point near the geographic north pole. This is called the **magnetic north pole**. The point at which south poles of magnets point is the **magnetic south pole**.

Angle of dip

At the magnetic equator, a magnet which is suspended freely remains horizontal to the earth's surface. However, this same magnet will bend downwards, making an angle with the earth's surface at places near the geographic poles. This angle is called the **angle of dip**.

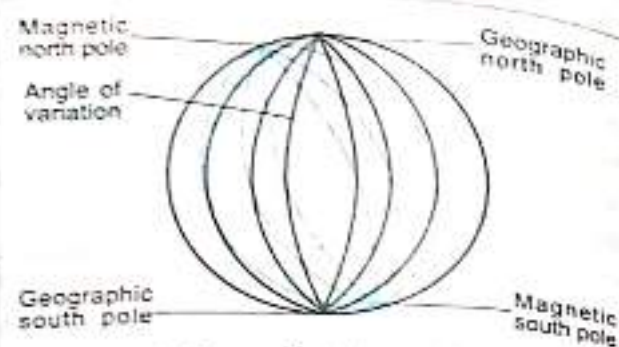


Fig. 14.19 Geographic and magnetic meridians



Fig. 14.20 The magnetic poles of the earth

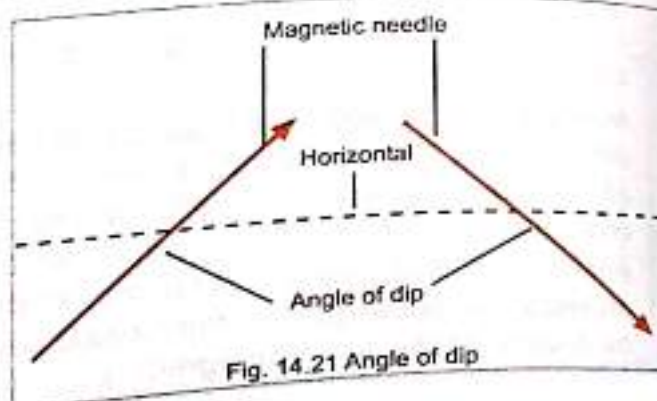


Fig. 14.21 Angle of dip

CAMPASS

A compass is an instrument that contains a magnetized pointer and shows the direction.

The pocket compass

It is basically a needle-shaped magnet which is pivoted on a piece of circular cardboard. The cardboard has the four directions marked on it in a clockwise direction. The magnet always takes up a north-south direction, no matter what direction the compass is held in the hand. To read the compass, the north marked on the compass must be in line with the magnet. Only under this condition the compass will give a true indication of direction.

The mariner's compass

Like the pocket compass, all the directions on the cardboard of the mariner's compass are marked in a clockwise direction. Several magnetized strips, with their north poles facing the north marked on the card, are stuck underneath the card. The card is placed in a bowl containing mercury so that as the ship rolls, the card always remains horizontal. The markings on the compass card show the direction in which the ship is sailing.

USES OF MAGNETS

Magnets are used in making:

- ▣ **Compass:** for finding directions.
- ▣ **Electrical instruments:** for measuring electric currents and voltage, e.g. ammeters and voltmeters.
- ▣ **Dynamos:** which produce electricity. Power stations generate large amounts of electricity by means of huge dynamos.

Electromagnets are used in:

- ▣ **Large cranes:** These magnets attract and move heavy loads of scrap iron and iron sheets. The electromagnet only lifts the loads when a current is flowing through it. Once



Good to know

The first ever magnetic compass was invented in ancient China. It was made up of lodestone which is a natural ore of iron.



the current is switched off, it ceases to be a magnet, and drops the load. In this way, the load can be moved from one spot to another.

- Telephone and electric bells to produce ringing sounds
- **Removing foreign bodies:** such as iron nails and other magnetic substances from a patient in hospital.
- **Magnetic separators:** to separate magnetic substances (iron, steel, nickel and cobalt) from non-magnetic substances e.g. tin, brass and copper.

Electromagnets in common devices

A magnetic field appears around a wire carrying current. A force acts on the wire carrying current when it is placed in a magnetic field. If the wire is free then it moves in the direction of the force acting on it. This force is used to turn the rotor of an electric motor, diaphragm or cone of a loud speaker and coil of measuring instruments, etc.

1. Electric motor

An electric motor is a device that converts electrical energy into mechanical energy.

It consists of a magnet and a coil which can rotate around its axis. When an electrified coil is placed in a magnetic field, forces act on its two sides in opposite direction as shown in figure 14.27. The two forces rotate the coil until it becomes parallel to the magnetic field. As soon as the coil becomes parallel to the

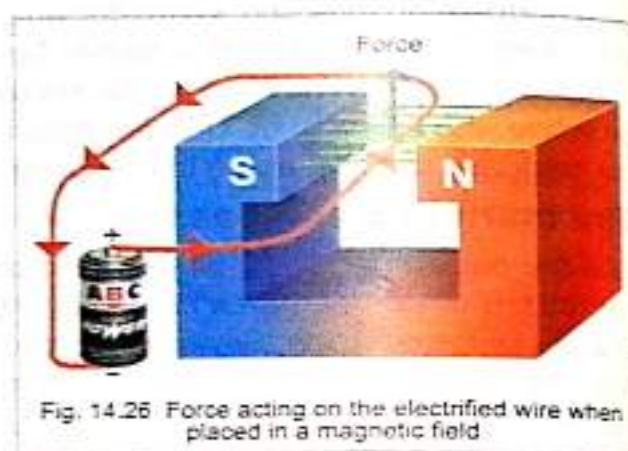


Fig. 14.26 Force acting on the electrified wire when placed in a magnetic field

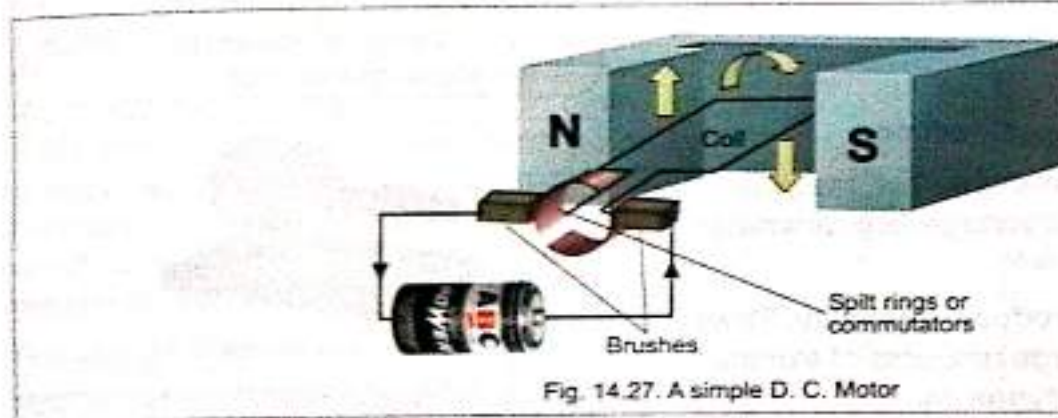


Fig. 14.27. A simple D. C. Motor

magnetic field, the direction of current is reversed so that the two forces continue to rotate the coil and produce the mechanical energy. The turning effect produced by the two forces acting on the coil can be increased by:

- (i) increasing the current in the coil

- (ii) increasing the number of turns of the coil
- (iii) using a stronger magnet and
- (iv) using a bigger coil.

2. Loudspeaker

It is a device that changes electrical energy into sound. It consists of a magnet, a coil and a paper cone. A hollow coil is fixed at the centre of the paper cone. The paper cone is so adjusted that the coil can move over a cylindrical magnet as shown in figure 14.28. When

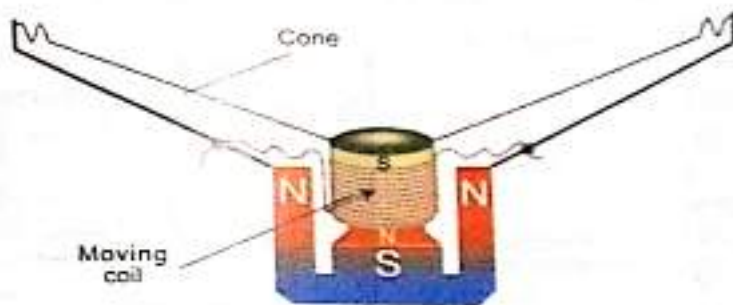


Fig. 14.28 A moving coil loudspeaker

the coil of the loudspeaker is connected to an amplifier, it moves in and out due to the changing current from the amplifier. The movement of the coil also causes the cone to vibrate with it. As the cone vibrates, it produces sound.

3. Generating electricity

Electric current in a coil causes it to move in a magnetic field. In this way, electrical energy is changed into mechanical energy. The reverse of it is that an electric current is produced when a wire or a coil is moved in a magnetic field. In this way mechanical energy is converted into electrical energy. This reverse effect is used in many devices such as electric generator, microphone etc.

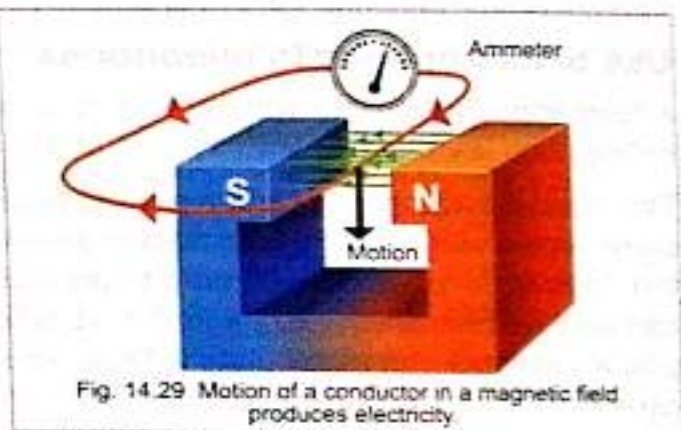


Fig. 14.29 Motion of a conductor in a magnetic field produces electricity.

(a) Electric generator

An electric generator is a device which changes mechanical energy into electrical energy. A simple generator is an alternating current generator as shown in figure 14.30. A coil is rotated about its axis in a magnetic field of a magnet. Each end of the coil is connected with a separate slip ring. The coil and the two slip rings all are mounted on the same shaft.

Two carbon brushes are used which touch the slip rings for making contact with them. As the coil rotates, the magnetic field crossing the coil also changes. This change in the magnetic field generates electricity across the ends of the coil.

(b) Microphone

A microphone is a device that converts sound energy into electrical energy. There are different types of microphone such as carbon microphone as shown in figure 14.31. When someone speaks before a microphone, its aluminium diaphragm vibrates by the sound waves falling over it. This varies the pressure on the carbon granules between the moveable carbon dome and the fixed carbon cap. This varies

the current passing through the microphone in the same way as the variation in the sound waves.

Nowadays, many other types of microphones are commonly used such as magnetic microphone, crystal microphones, and capacitor microphones.

Use of microphone in telephones

A telephone is a device which is used to communicate from distance. It consists of a microphone, earphone, alarm system and a dial system.

The mouthpiece contains carbon powder packed between the two plates. One of the plates is connected with a thin metallic diaphragm. When someone speaks before the microphone, the diaphragm vibrates according to the sound waves. This varies the pressure on the carbon particles which results in the variation in the electrical resistance of the carbon powder between the metal plates. Thus, sound waves produce a variation in the electric current.

In the earphone, electromagnet is used to convert electrical signals into sound. It consists of an electromagnet and a thin iron disc. When varying electric current passes through the coil of electromagnet, it causes the iron disc to vibrate according to the vibrations in the electric current. As the disc vibrates, it produces sound.

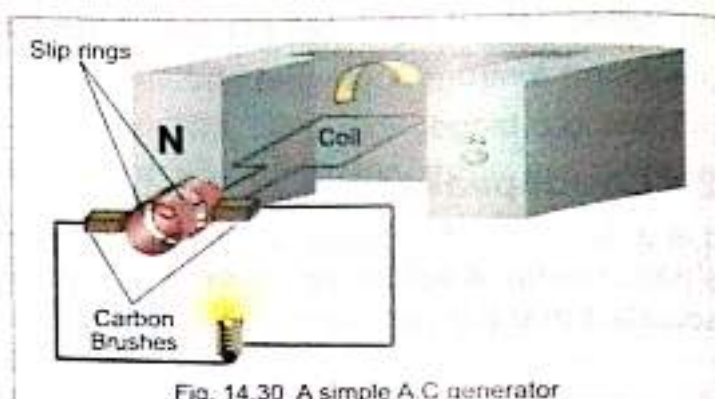


Fig. 14.30 A simple A.C generator

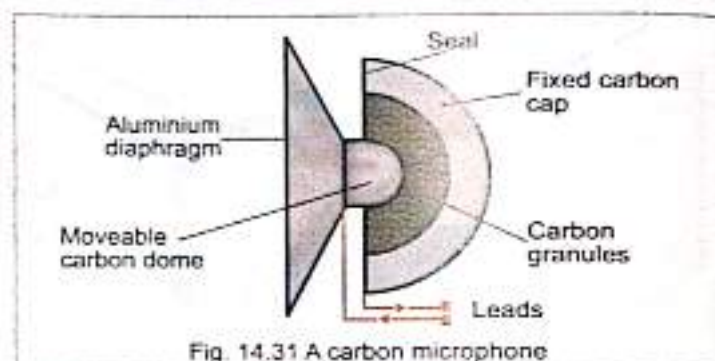
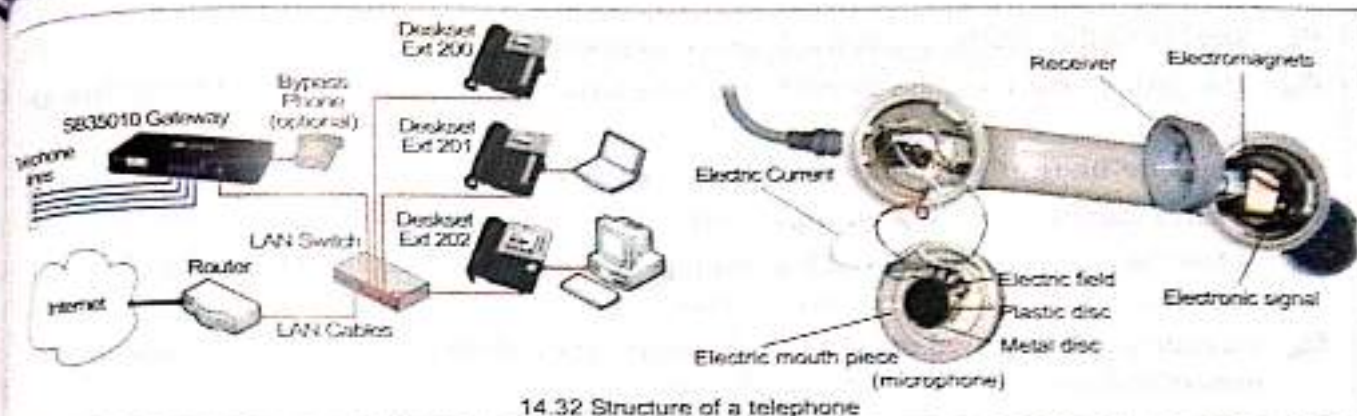


Fig. 14.31 A carbon microphone



Amazing facts!

The tape used in tape recorders and video cassette recorders consists of a plastic tape with a magnetic material such as iron oxide or chromium oxide coated on it. The magnetic head induces patterns of magnetism on the magnetic material on the tape. When replayed, these patterns induce electrical signals in the head. These are reproduced as sound and video.

Let's work in team!



Under the supervision of your teacher, construct a working model of an electric bell. Demonstrate its working and explain its working mechanism to the students of other grades.

Teacher's corner



Conduct an experiment in science lab in which teach students how magnetic lines of force are drawn by using a bar magnet and compass.



KEY POINTS

Here is a list of key points to remember:

- 🔑 A magnet is an object that can attract the objects of iron, steel nickel or cobalt.
- 🔑 Substances such as iron, steel, cobalt and nickel which are attracted by magnets are called magnetic substances. Substances which are not attracted by a magnet are called non-magnetic substances.
- 🔑 A magnet has two poles called north-pole or N-pole and south-pole or S-pole. The same poles repel each other. However, opposite poles attract each other.
- 🔑 Force of attraction is maximum at magnetic poles.
- 🔑 Soft iron is easily magnetised. It is also easily demagnetized.

- 🔑 Steel is neither easily magnetized nor demagnetised.
- 🔑 The path of the compass needle in a magnetic field is called the magnetic line of force.
- 🔑 Magnetic lines of force pass from north to south and they never cross each other.
- 🔑 When a current is passing through a wire, a magnetic field is produced around it.
- 🔑 When the current passes through a straight wire, the magnetic field is produced around the wire in the form of concentric circles.
- 🔑 Electromagnets are used in electric bells, telegraphs, telephones, loudspeakers, dynamos, motors and several other electrical devices.
- 🔑 When a current is passed through a long coil, its magnetic field is similar to that of a bar magnet.
- 🔑 Electric motor converts electrical energy into mechanical energy. It is based on the principle that a force acts on a current-carrying wire when placed in a magnetic field.
- 🔑 A loudspeaker also works on the principle of electric motor. Variation of the electric current in a coil causes it to vibrate in the magnetic field and produces sound.
- 🔑 Electric generator converts mechanical energy into electrical energy. It is based on the principle that when a wire or a coil is moved in a magnetic field, electricity is produced.
- 🔑 In a microphone, sound waves cause vibration in the diaphragm and hence causes variation in the electric current.
- 🔑 The earth behaves as if it has a large magnet in it.
- 🔑 We use electricity to make strong magnets.
- 🔑 A magnetic compass helps sailors and navigators to find the directions.

KEY WORDS

Coincide:	correspond, match.
Magnetism:	attractive property of a magnet.
Repel:	to resist, push back.
Meridian:	an imaginary circle on the earth.
Pivot:	fulcrum, hinge.
Amplifier:	electronic device used for increasing sounds.
Scrap:	useless metal objects.
Diaphragm:	a thin sheet that forms a partition.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Briefly explain the term magnet.
2. What are magnetic and non-magnetic substances? Give two examples of each.
3. State four important properties of a magnet.
4. How will you find the poles of a magnet? Explain briefly.
5. Describe an experiment to show that like poles repel and unlike poles attract each other.
6. With the help of an experiment, explain magnetic induction.
7. What do you understand by a temporary magnet and a permanent magnet?
8. Define a magnetic field. Describe how the lines of force of a magnetic field can be drawn on a paper.
9. Which type of magnetic field will be formed by a current-carrying long coil? Explain it by describing an activity.
10. Explain the working principle of an electric motor.
11. Describe the working of an electric generator.
12. What do you know about a microphone.
13. How does a loudspeaker produce sound?
14. How does a telephone work?
15. State four important uses of magnets.

B. Fill in the following blanks:

1. Magnetic field of a magnet is stronger at
2. The magnetic field is at its middle.
3. Magnetic field is present around a carrying conductor.
4. A force acts on a wire carrying current when placed in a field.
5. A loudspeaker converts electric into sound.

6. The receiver of a telephone converts the varying into sound with the help of an electromagnet.
7. Poles of a magnet always exist in
8. A magnetic compass is a simple device which has a needle.
9. Lodestone is a natural magnet which is an ore of
10. are used in a dynamo.

C. Decide whether the following statements are TRUE/FALSE:

- | | TRUE | FALSE |
|---|--------------------------|--------------------------|
| 1. A magnet pulls small objects of copper and brass towards it. | ☐ | ☐ |
| 2. The magnetic field of a current-carrying straight wire is in the form of concentric circles. | ☐ | ☐ |
| 3. The magnetic field of a current-carrying long coil is similar to that of a bar magnet. | ☐ | ☐ |
| 4. The electric motor and electric generator work on the same principle. | ☐ | ☐ |
| 5. A speaker converts the electrical vibrations into the sound vibration. | ☐ | ☐ |
| 6. The earth behaves like a large magnet. | ☐ | ☐ |
| 7. Nickel is a non magnetic substance. | ☐ | ☐ |
| 8. Electromagnets are permanent magnets. | ☐ | ☐ |
| 9. A magnet attracts all metals towards itself. | ☐ | ☐ |
| 10. A magnet has only one pole. | ☐ | ☐ |

D. Give one word answer of the following questions:

1. The most popular metal used to make a magnet.
2. Write the name of one substance which is non-magnetic.
3. Which metal is not easily magnetised?
4. In which direction do the lines of force travel?
5. Which thing is itself a large magnet?

6. Tick mark (✓) the most appropriate answer for the following statements:

Magnetic force is more:

- a. near the poles of the magnet.
- c. away from the magnet.

- ☐ b. at the middle of the magnet.
- ☐ d. far away from the magnet.

☐
☐

If current is passing through a straight wire:

- a. a current starts flowing in other objects.
- c. there is no effect on the compass needle.

- ☐ b. enter into the north pole.
- ☐ d. magnetic field is produced.

☐
☐

Magnetic lines of force:

- a. cross one another
- c. are always parallel.

- ☐ b. enter into the north pole.
- ☐ d. are always directed in a straight line.

☐
☐

A microphone:

- a. converts electric current into sound.
- b. converts electrical energy into mechanical energy.
- c. converts sound into current vibrations.
- d. is a device used to make an electromagnet.

☐
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Discovery of magnetism was made by the people of

- a. China
- c. Malaysia

- ☐ b. Magnesia
- ☐ d. England

☐
☐

Homework Assignment



Study and make a note on the uses of electromagnets in the field of medical science. List important electromagnetic machines which are used in hospitals.

FUN WITH SCIENCE

Place two bar magnets over each other in a way that their opposite poles are on the same side. Separate them by inserting pencils and then tie them with sticking tape. Now remove the pencils, Floating magnets are ready.

UNIT 15

The Earth and Space

Learning Objectives

At the end of this unit, students should be able to:

- understand and define rocks and explain their different types.
- understand the continental drift.
- know about the minerals found in Pakistan and their uses.
- know about the heavenly bodies.
- understand about the origin of universe.
- learn that the origin of universe is assumed to be the result of a "big bang".
- learn that millions of galaxies and stars exist in the universe, which are distant from us by incomprehensible distance.
- understand that the stars are divided into various groups called constellations.
- understand and describe various characteristics of the nine planets of the solar system.
- understand and define asteroids, comets, meteors, meteorites and artificial satellites.
- understand and describe the uses of artificial satellites.

LET'S FIND OUT WHAT ROCKS ARE!

The earth's crust is made up of solid rocks. These rocks are physical and chemical units of matter collected together in the form of great masses. Rocks are of different kinds. They contain different kinds of metals and non-metals. Rocks differ from each other in their shape, size, degree of hardness, texture, colour, origin and chemical nature. The scientists who study about rocks and their behaviour are called **geologists**.

Kinds of Rocks

According to the mode of formation, rocks are divided into three groups:

1. Igneous rocks
2. Sedimentary rocks
3. Metamorphic rocks

1. IGNEOUS ROCKS

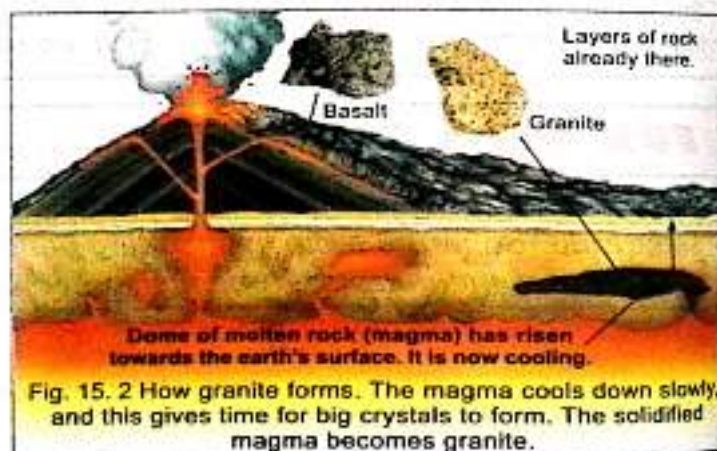
Igneous rocks are formed from the hot molten rock material that comes out of the earth. The molten material called **magma** makes its way out of the earth through cracks in earth's crust. After coming out of the earth, it solidifies to form rocks. We get metals like tin, copper, aluminium, iron etc. from these rocks. **Granite** and **basalt** are common examples of igneous rocks.



Fig. 15.1 a. Granite



Fig. 15.1 b. Basalt



2. SEDIMENTARY ROCKS

These rocks are formed by the accumulation of sediments. Water, wind and ice carry away pieces of rocks, mud, pebble, gravel, sand etc. and deposit them elsewhere. These deposits are in the form of layers. All the time, fresh layers of sediment are piled over the previous one. The weight of the top layer presses heavily on the lower layers which, in due course of time, harden to form rocks.

Sometimes, small plants and animals also flow down with water into the sea and get buried in the rocks. The remains of these animals and plants form **fossils**.

Sandstone, shale, limestone, conglomerate and dolomite are common examples of sedimentary rocks.



Fig. 15.3 Sedimentary rocks

3. METAMORPHIC ROCKS

Metamorphic rocks are formed from igneous or sedimentary rocks when they are exposed to heat and pressure. The rock-forming minerals undergo physical and chemical changes on account of heat and pressure. Hence, they are called metamorphic rocks. These rocks are formed because of the re-crystallization of minerals that are already there. They often have bands of different colours and sizes due to mineral impurities.

Slate, marble, gneiss and peat are the common examples of metamorphic rocks.



Fig. 15.4 Metamorphic rocks

MINERALS

Rocks are made of chemical materials called **minerals**. Minerals are found in various forms, which make it easy to identify them. A mineral is a solid, naturally-occurring inorganic substance.

There are about two thousand known minerals, each with their own distinct properties. Minerals can be identified by making use of their properties of colour, lustre, hardness, specific gravity etc.

Minerals are very important for a country's

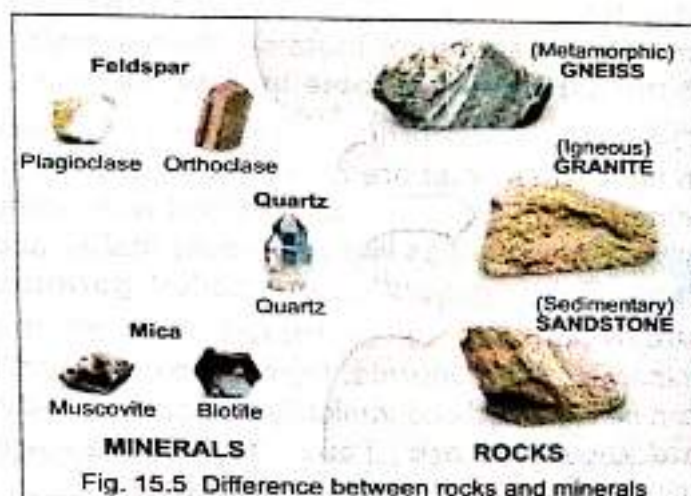


Fig. 15.5 Difference between rocks and minerals

economy. A country rich in mineral resources, is a rich country. Minerals can be classified into two groups-the **metallic** and the **non-metallic minerals**. Metallic minerals are those from which we can obtain metals. The non-metallic minerals include sand, clay and other minerals. Almost 95% of the earth's crust consists of rocks made of non-metallic minerals.

METALS AND THEIR IMPORTANCE

Metals are of great importance to man. More than 80 i.e., 75% of the elements, known to us, are metals. Some metals like iron, aluminium, copper and lead are very common, while others like platinum and uranium are rare. Man has made use of metals in various ways



Fig. 15.6 Uses of metals in our daily life

since the prehistoric days. At present, metals are extensively used in our daily life as well as industries. At home, we use cooking utensils made of iron, copper, aluminium, steel etc. Steel is also used for making ships, locomotives, sewing machines, cars etc. Copper is a good conductor of electricity and heat. Its largest use, therefore, is in electrical wiring and electrical instruments. Mercury is being used in making thermometers. Silver and gold are used for making ornaments. Many modern facilities would not have been possible without metals. In short, metals have become essential in our modern civilization.

OCCURRENCE OF METALS

In nature, metals are found to occur both in the **free** and **combined** states. The earth's crust is the source of metals. When a metal is found in the free state, it is said to occur in the **native state**. **Noble metals** like silver, gold and platinum occur in the native state.

The naturally -occurring compounds of metals in the earth's crust are called minerals. These minerals are generally associated with some unwanted impurities like clay, rocky matter and sand. These impurities are called **gangue**.

Metals can not be extracted from all the minerals. The minerals, from which the metal can be extracted economically and conveniently, are known as **ore**. Thus, all the ores are minerals, but all minerals are not ores.

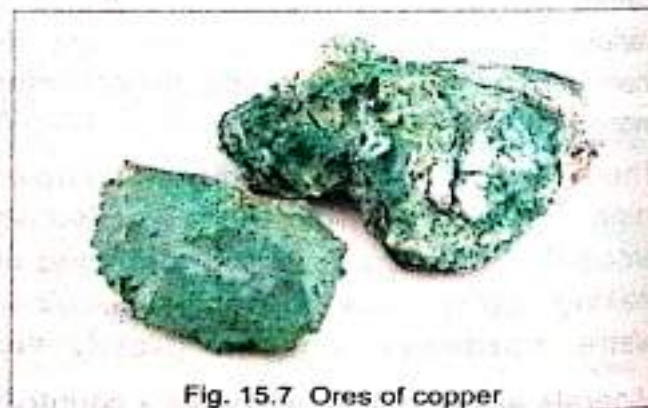


Fig. 15.7 Ores of copper

The reactive metals like iron, aluminium, zinc, calcium, sodium, magnesium etc always occur in the combined state.

The branch of science dealing with the method of extraction of metals from their ores and the preparation of alloys is called **metallurgy**.

DIFFERENCES BETWEEN METALS AND NON-METALS

The main differences between the physical properties of metals and non metals are given in Table 15.1.

Table 15.1. Differences between metals and non-metals

Characteristics	Metals	Non-metals
Physical state	They are solid at room temperature except mercury which is a liquid.	They are either solids or gases except bromine which is a liquid.
Metallic lustre	They are lustrous (shiny).	They are non-lustrous or dull, except graphite and iodine which are lustrous non-metals.
Density	They usually have a high density.	They usually have a low density.
Malleability	They are malleable and can be hammered into sheets	They are not malleable. They are brittle, i.e. they break into pieces when pressed hard.
Ductility	They are ductile and can be drawn into wires.	They are non-ductile.
Conductivity	They are good conductors of heat and electricity.	They are bad or poor conductors of heat and electricity except graphite which is a good conductor.
Melting and boiling points	They mostly have high melting and boiling points	They have low melting and boiling points except graphite and diamond which have high melting and boiling points.
Hardness	They are hard except Na and K.	They are soft except diamond which is the hardest substance.
Sonorous	They are sonorous and produce characteristic sounds.	They are non-sonorous.
Tensile strength.	They have high tensile strength.	They have low tensile strength.

ALLOYS

An alloy is a homogeneous mixture of two or more metals or one or more metals and a non-metal. Metals are mixed in the molten state in a fixed proportion by mass to form an alloy.

The Purpose of Making Alloys

1. To harden the metal. Gold becomes hard by mixing copper with it.
2. To change the colour of metals e.g. an alloy of copper and aluminium (known as aluminium bronze) has a beautiful golden yellow colour. It is used for interior decoration.
3. To prevent corrosion, e.g. stainless steel is both acid proof and rust proof.
4. To alter the reactivity of metals. Sodium amalgam reacts with water slower than pure sodium.
5. To improve properties of metals. Duralumin is an alloy of Magnesium and Aluminium. It is light and is used in making aircraft bodies.

Some Common Alloys

Table 15.2 gives the list of some commercially important alloys, their constituents, and their uses.

Table 15.2. Common alloys and their uses

Alloy	Constituents present	Uses
□ Steel	Fe, C	Tools, rails, bridges, tanks, ships, utensils.
□ Stainless steel	Fe, Cr, Ni	Cooking utensils, cutlery, surgical instruments.
□ Brass 	Cu, Zn	Utensils, parts of watches and musical instruments, cartridges, cases, machine parts.
□ Bronze 	Cu, Sn	Statues, ornaments, coins, bells, medals.
□ German silver	Cu, Zn, Ni	Ornaments, utensils, decorative pieces.

CORROSION OF METALS

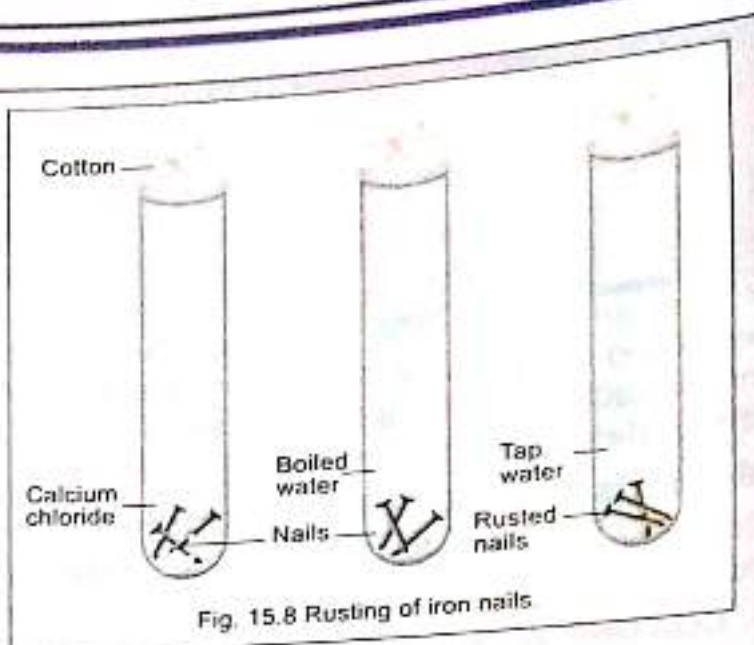
You must have noticed that iron articles and utensils, when exposed to moist air, get gradually coated with reddish brown coating called **rust**. Rusting is a slow oxidation process. Chemically, rust is **hydrated ferric oxide** $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$.

ACTIVITY TIME! To show that air and water are necessary for rusting.

Take three test tubes and number them. Place a small amount of anhydrous calcium chloride in the first test tube to dry up the air. Fill the second test tube completely with

boiled water from which dissolved oxygen has been completely driven out by boiling. Pour a small amount of tap water in the third test tube. Now put three/ four small iron nails in each test tube. Plug the mouths of all the three test tubes with cotton (Fig. 15.9). After 3 days, take out the nails and examine them closely.

You will find that the nails in the first and second test tubes are free from rust, while that in the third test tube has rusted. The above activity shows that for rusting to take place, both air (oxygen) and water are essential.



You must have noticed that aluminium vessels became dull grey very soon after use. Copper wires lose their shine and even acquire a green coating as they get older and silver ornaments turn black. Similarly, surfaces of other metals are eaten away due to atmospheric conditions, or by water containing dissolved salts.

This process by which metals are oxidised under the influence of atmospheric conditions (moisture in air) is called **corrosion**. Metals can also be corroded by acids.



Fig. 15.9 Colour and porous surface texture of rust

Metal surface interact with oxygen, moisture and other gases present in air and slowly get coated with oxide, hydroxide or carbonate of the metal. Thus, metals are eaten away or corroded.

Corrosion of metals causes great economic loss. It is estimated that about 15% of the total world production of iron is destroyed by corrosion. This corrosion causes a very serious loss to national economy. Corrosion also causes various accidents due to wear and tear of bridges, building structures, rails, etc. where iron is a main component.

higher. Iron deposits have also been located in the Dera Ghazi Khan area. In Hazara, 1.5 million tons of magnesite has been proved. Deposits of manganese in Las Bela, graphite in Azad Kashmir, fluorite in Kalat, rock phosphate in Hazara Presence of bauxite in Salt Range, talc in swat, uranium in Dera Ghazi Khan, china clay in

Nagar Parkar, and gold in the Gilgit area have been located and efforts are being made to extract them. Some of the world's best emeralds are now being mined from Swat. Commercial deposits of rubies and aquamarines have been found in Gilgit Agency.

Movement in the Earth's Crust

For thousands of years, people thought that the earth's crust was fixed in its position on the earth. However in the 1960s, it was proved that land is continuously but slowly floating around like logs on water. This is called the **continental drift**. But the movement is very, very small; only a few centimetres every year. This was proved by two British scientists **Fred Vine and Drummond Matthews**.



Fig. 15.15



Fig. 15.16 Fred Vine and Drummond Matthews

A long time back all continents were joined in the form of one huge land mass called **pangaea**. Then pieces started breaking up and drifting away.



Fig. 15.17 Continental drift.

The concept of continental drift was first proposed by **Alfred Wegener**. In 1912, he noticed that the shapes of continents on either side of the Atlantic Ocean seem to fit together (for example, Africa and South America). South America and Africa are moving apart at an average of 5.7 cm per year, due to the seafloor spreading along the Mid-Atlantic Ridge. This is comparable to the growth speed of a



Fig. 15.18 Alfred Wegener



Fig. 15.19 Pangaea

finger nail. Evidences for continental drift are now extensive, such as plant and animal fossils of the same age, found around different continent shores, suggesting that these shores were once joined.

HEAVENLY BODIES

In day light, you can only see the sun. Due to the brightness of the sun, other heavenly bodies cannot be seen. Look up at the sky on a clear night. You can see the moon and thousands of stars twinkling in the sky. If you keep watching them over several nights, the stars appear to move across the sky. Some of the bright heavenly bodies do not twinkle. They are the planets. The sun, moon, stars, planets and other objects in the sky are known as heavenly bodies.

THE UNIVERSE AND ITS ORIGIN

The universe is everything that exists—stars, planets, moons, other heavenly bodies and everything that exists on these heavenly bodies, such as animals and plants on the earth, and the vast empty space in between. Nobody knows how big the universe is. It is impossible to even imagine its size. In fact scientists have shown that the universe is getting bigger and bigger, as the balloon is blown up, the dots on it move away from each other. Scientists

ACTIVITY TIME! To show expansion of universe.

Draw five or six dots a little apart from each other on a balloon with a sketch pen. Blow air into the balloon (Fig. 15.21). What happens to the dots?



Fig. 15.20 The dots on a balloon move away from each other as the balloon is blown up.

have shown that the universe is getting bigger and bigger. The galaxies are all moving away from each other just as the dots on the balloon move away from each other when it is blown up.

Astronomers found that the universe was expanding. So, they put forward a theory to explain how the universe originated. They believe that about 15 billion years ago, all the matter in the universe was gathered

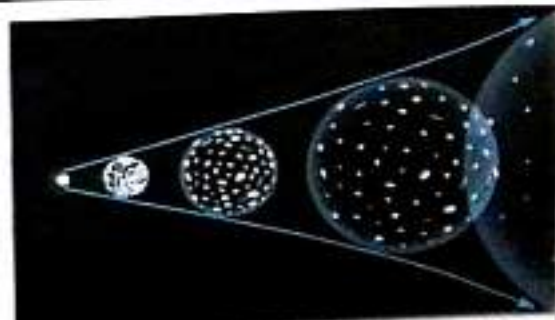


Fig. 15.21 The Big Bang and the expanding universe

into a single mass. Suddenly the mass exploded, sending particles flying in all directions. These particles formed the galaxies with their stars and planets. These galaxies are still flying away from each other because of the explosion. This is called the **Big Bang Theory**.

The branch of science that deals with the study of heavenly bodies is called **astronomy**. People who study the universe are called **astronomers**. The most important instrument used by astronomers is the **telescope**. It is very helpful to see the distant objects.

GALAXIES

Stars are scattered in the sky in groups. Each group has billions of stars in it. Such a group of stars is called a **galaxy**. The sun, the earth and other planets, and all the stars that you can see in the sky belong to a galaxy called the **Milky Way**. It is a spiral-shaped galaxy with a bulge in the centre. The sun is situated on one of the arms of the spiral. On a clear night it appears like a band of light shining across the sky.

STARS

Stars are huge spinning balls of hot luminous gases. All stars give out their own light. Most stars are made up almost entirely of two gases: hydrogen and helium. In the centre of the stars, hydrogen atoms combine to form helium atoms. This process is called **fusion**, during this process huge amounts of energy is released in the form of heat and light. The sun is also a medium-sized star. Some stars are small while others are bigger than the sun. According to modern research, the number of galaxies in the universe ranges between 200 billion to 2 trillion, containing an average of 100 billion stars each. Thus the total number of stars in the universe is so large that it is difficult to even imagine it!

PLANETS

Planets are heavenly bodies that revolve around a star called the sun. They do not have their own light. Their surface reflects the light of the sun to us. They are smaller than stars. Our earth is also a planet. Table 15.3 gives the major differences between stars and planets.

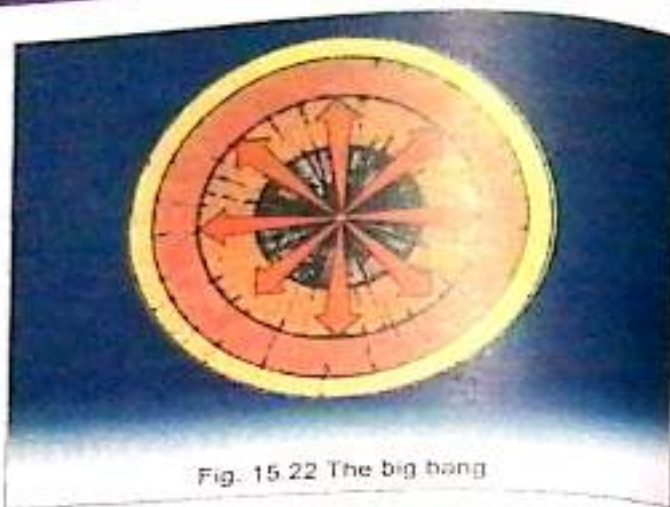


Fig. 15.22 The big bang



Fig. 15.23 The milky way

Table 15.3 Major difference between stars and planets

Stars	Planets
☐ emit their own light	☐ do not emit their own light
☐ are made up of hot gases	☐ are made up of rocks
☐ when seen from the earth, they twinkle	☐ they do not twinkle
☐ massive in size	☐ smaller than stars

CONSTELLATIONS

Thousands of years ago, astronomers divided the stars into groups and drew imaginary pictures around them, such as that of a hunter or a bear. This made it easier for them to remember the star patterns. Such a group of stars is called a **constellation**. The shape of a constellation always remains the same. Constellations appear to move from east to west. **Today 88 constellations have been identified by astronomers.** Remember, however, that the stars in a constellation are actually unrelated. They are at widely-varying distances from the earth. However, when viewed from the earth, they appear to be at the same distance and form a group.

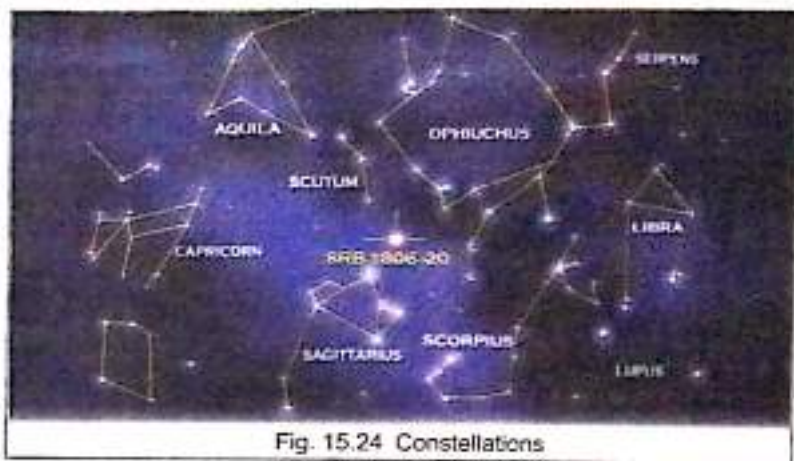


Fig. 15.24 Constellations

NATURAL SATELLITES OR MOONS

A heavenly body that revolves around a planet is known as a **natural satellite** (or moon) of the planet. Most planets have moons revolving around them.

The earth has only one moon. It is held in orbit around the earth because of the earth's gravity. It shines because it reflects the light of the sun. It is dry and barren with no atmosphere. Its surface is covered with several craters and mountains. It has a diameter of about one-fourth that of the earth. Its mass is about one-hundredth that of the earth. It completes one revolution around the earth in 27.3 days. It also rotates once on its axis in the same period of time. Its distance from the earth is about 384,400 kilometres. Due to changes in the position of the earth, the moon appears to change its shape. When the moon is in between the earth and the sun, we do not see the moon at all. It is called the **new moon**. Two or three days after this, we see only a part of the moon. This is called the **crescent moon**. Within a week, we see half of the moon. This is called the **first quarter**. When we see more than half of the moon, it is called the **gibbous moon**. Gradually,

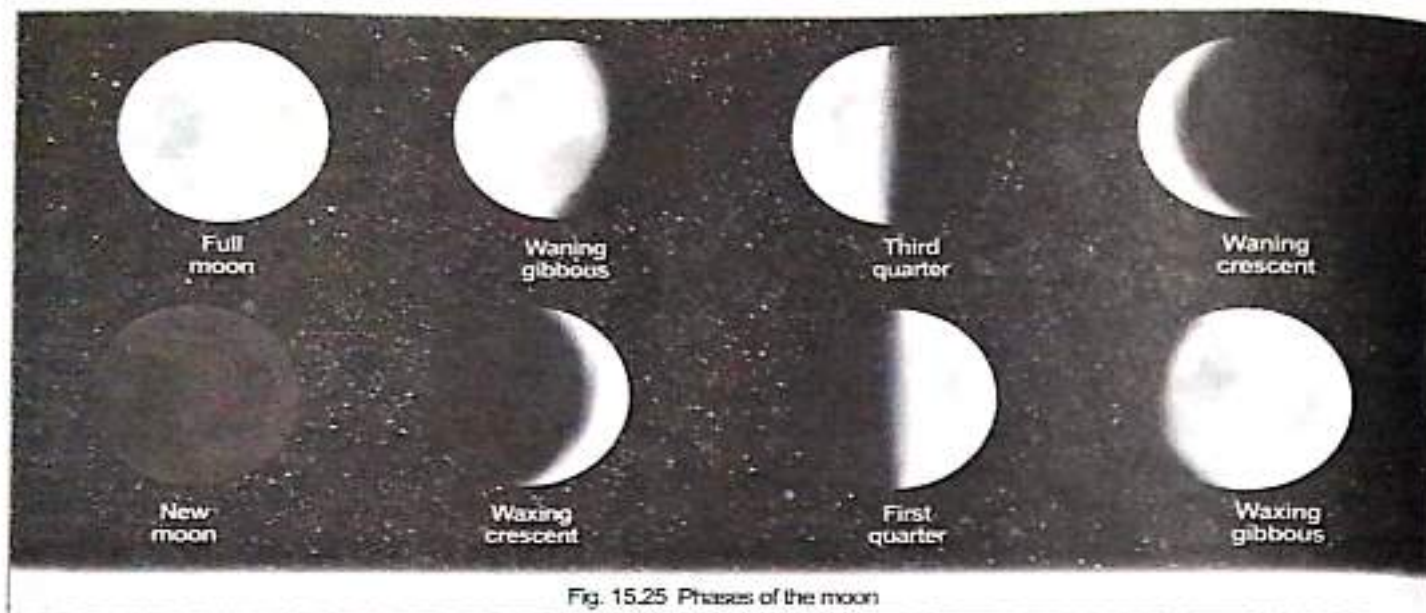


Fig. 15.25 Phases of the moon

the shape of the bright portion of the moon becomes bigger and bigger. On the fifteenth day, we see the **full moon**, when the earth comes between the sun and the moon. These appearances of the moon are known as the **phases of the moon** (Fig. 15.26).

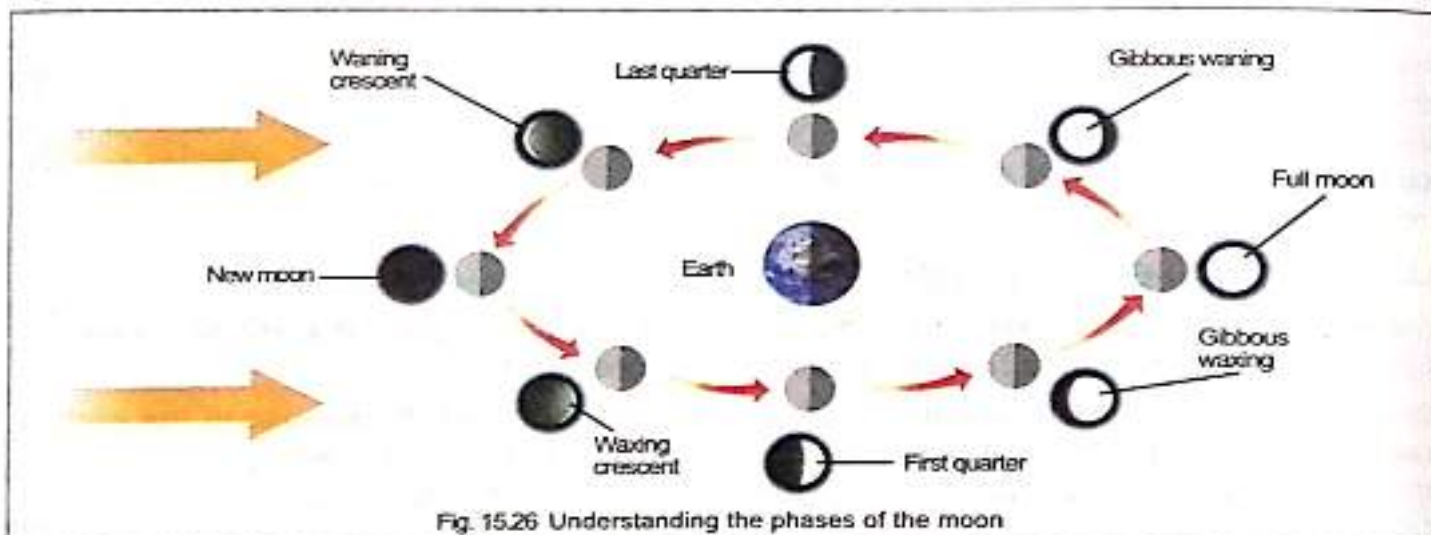


Fig. 15.26 Understanding the phases of the moon

Good to know

In our solar system, so far, 53 moons have been discovered on Saturn, but there may be more.

Jupiter has 69 known moons. Mercury and Venus do not have any moons. Mars has two moons named **Phobos** and **Deimos**. Uranus has 27 known moons. Neptune has 8 moons revolving around it. Only one moon has been discovered on Pluto till now.

Asteroids

An asteroid is a large and irregularly-shaped rocky material that orbits around the sun. A large number of asteroids lie between the orbits of Mars and Jupiter. The largest asteroid is **Ceres** (diameter 1003 km). The size of asteroids varies from a kilometre to a few hundred kilometres.

Comets

Comets are heavenly bodies which are made up of ice and dust and revolve around the sun in very long orbits. A comet appears like a ball of fire with a long bright 'tail' as it approaches the sun. The tail always points away from the sun. The famous **Halley's Comet** appears after every 76 years. It last appeared in 1986.



Fig. 15.27 Halley's comet

Meteors and meteorites

Meteors are small objects made up mainly of stones present in space. They regularly enter the earth's atmosphere. As a meteor enters the earth's atmosphere at high speed, it is heated because of air friction, and in most cases it burns to ashes. As it heats up and burns, it appears as a glowing streak of light and is mistakenly called a **shooting star**.



Fig. 15.28 A shooting star



Fig. 15.29 The Barringer Crater in Arizona, USA was formed when a large meteorite struck the earth long ago.

You may have seen shooting stars in the sky on a clear night.

If a meteor is large, it may fall on the earth's surface before being completely burnt out. Such meteors are called **meteorites**.

ARTIFICIAL SATELLITES

Scientists of several countries including Pakistan have sent artificial satellites into space. These satellites revolve around the earth. The first satellite was sent by USSR on October 4, 1957. It was called **Sputnik-I**. Today, there are many satellites in space. Artificial satellites are very useful to us because of the following reasons:

- They help in television and radio transmission.

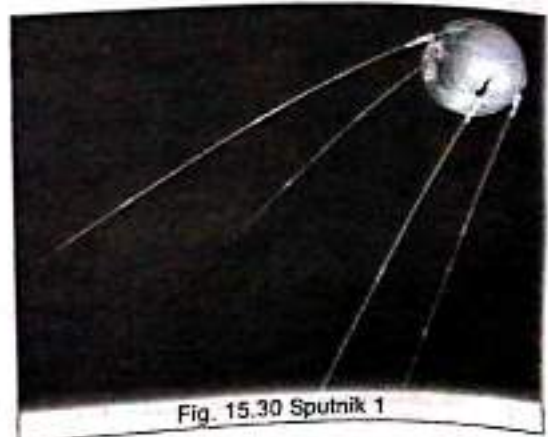


Fig. 15.30 Sputnik 1

- They help in telecommunication.
- They help us to observe and forecast the weather by sending images of clouds to the earth.
- They help in locating minerals and studying agricultural yield on the earth by photographing land from above.
- They help scientists know more about the universe by collecting information about space.



Amazing facts!

Geology is the study of the earth. Geologists study the history of the earth as a planet, the substances it is made up of and the changes it undergoes, mainly through the study of rocks on the earth.

Let's work in team!



Search and write about the spacecraft which has gone out of our solar system into outer-stellar space. What is its name? When was it launched? When it came back? When was it confirmed that it has gone into outer space? Make a small model of it to be presented in the class.

Teacher's-corner



Conduct a multimedia presentation in which show the process of formation of sedimentary, metamorphic and igneous rock.



KEY POINTS

Here is a list of key points to remember:

- 🔑 The earth's crust is made up of rocks and rocks are made up of minerals.
- 🔑 Igneous, sedimentary and metamorphic are the three kinds of rocks.
- 🔑 Minerals are naturally occurring materials that contain metals and compounds of metals.
- 🔑 Minerals are obtained from the earth. They are divided into two groups: metallic and non-metallic minerals.
- 🔑 Metals occur both in free as well as combined state in nature.
- 🔑 An ore is a mineral from which one or more metal may be extracted profitably and conveniently.
- 🔑 Most ores occur as sulphides, oxides, carbonates and halides.
- 🔑 The unwanted impurities present in an ore are called gangue.
- 🔑 A mineral is identified by its colour, lustre and hardness.
- 🔑 Metallurgy is a process of extracting metals from their ores.

- 🔑 An alloy is a homogeneous mixture of two or more metals and sometimes of metals and non-metals.
- 🔑 Alloys play an important role in the service of man.
- 🔑 Alloys are harder and more resistant to corrosion.
- 🔑 Stainless steel, brass, bronze, solder etc. are important and useful alloys.
- 🔑 Metals are generally hard, malleable, ductile, lustrous and sonorous.
- 🔑 Eating away of metals by oxygen, water, acids or other chemical is called corrosion.
- 🔑 Air and water are necessary for corrosion to take place.
- 🔑 Corrosion can be prevented by ailing, painting, galvanizing, electroplating, tinning and anodizing.
- 🔑 Rusting is a slow oxidation process.
- 🔑 The universe comprises everything that exists, which includes stars, planets, moons other heavenly bodies, everything that exists on these heavenly bodies, as well as the vast empty space in between.
- 🔑 Scientists think that the universe was born about 15 billion years ago after a huge explosion called the Big Bang.
- 🔑 A group of billions of stars make up a galaxy. Our solar system is in the galaxy called the Milky Way.
- 🔑 Stars are huge spinning balls of luminous gases that give out heat and light. The sun is a star.
- 🔑 Planets are heavenly bodies that revolve around the sun. They do not give out their own light.
- 🔑 Constellations are stars that appear to form a pattern when viewed from the earth.
- 🔑 Moons, asteroids, comets and meteors are other heavenly bodies in the solar system.
- 🔑 Artificial satellites are useful in communication, weather forecasting, studying land and providing information about space.

KEY WORDS

- Metamorphic:** related to change in form.
- Sediment:** matter that settles down as a layer.
- Igneous:** related to volcanic activity.
- Malleable:** that can be pressed into sheets.
- Ductile:** that can be drawn into wires.

Waxing:: increase in the bright side of the moon.

Waning: decrease in the bright side of the moon.

Gibbous: convex-shaped.



TEST YOUR KNOWLEDGE

A. Answer these questions:

1. Name three principal classes of rocks.
2. Give two examples each of the igneous rocks, sedimentary rocks and metamorphic rocks.
3. What is an ore? How do metals occur in nature?
4. How is an ore different from a mineral?
5. Define metallurgy and write four differences between metals and non-metals.
6. Give four differences between metals and non-metals.
7. What is an alloy? Name two alloys each of Fe and Cu.
8. What do you understand by the term corrosion of metals? Name the agents which cause corrosion. Name three methods to prevent the corrosion of metals.
9. While looking up at the sky, how can you distinguish between a planet and a star? Give four ways in which stars are different from planets.
10. Both galaxies and constellations are groups of stars. Give two differences between them.

B. Fill in the following blanks:

1. Minerals are, occurring substances.
2. Movement of the earth's crust is called
3. A mineral used for commercial production of metal is called
4. An is a homogeneous mixture of two or more metals.
5. Brass is an alloy of and
6. Most stars are made up of two gases and

1. A cluster of billions of stars makes up a

C. Decide whether the following statements are TRUE/FALSE:

1. Any mineral deposit is known as an ore.
2. Metals in the pure state exhibit metallic lustre.
3. Stainless steel is rust proof.
4. Galvanization is the process of painting the surface of iron.
5. The galaxies are moving away from each other.
6. Stars are made up of rocks.
7. Meteors are big objects mainly made up of stones.

TRUE	FALSE
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

D. Choose the most appropriate answer from the following:

1. A galaxy such as the Milky Way contains:
 - a. a few thousand stars.
 - b. a few million stars.
 - c. a few billion stars.
 - d. only a few thousand stars but millions of planets.
2. The large number of rocks that lie between the orbits of Mars and Jupiter are called:
 - a. comets.
 - b. asteroids.
 - c. meteors.
 - d. meteorites.
3. Artificial satellites are sent in space by scientists because:
 - a. they look beautiful in the sky.
 - b. every country wants to break the record of the largest number of satellites sent.
 - c. they serve as stopovers for people going to the moon.
 - d. they are useful in communication, forecasting weather, locating minerals and in studying outer space.
4. Astronomers gave the Big Bang theory based on the observation that:
 - a. the universe is expanding.
 - b. the universe is contracting.
 - c. the size of the universe is not changing.
 - d. a few years ago, people saw a big explosion in the sky.
5. The first satellite was sent by:
 - a. USA in 1957
 - b. USSR in 1960
 - c. Japan in 1965
 - d. USSR in 1957

Homework Assignment

Search, study and write a note on the giant continent Pangaea.

FUN WITH SCIENCE

Track the movement of stars: You will need, a piece of chalk, another person to help you

Procedure:

For doing this investigation, you will have to stay up till late night. So the first thing that you require is the permission from your parents!

- ❑ Carry out this investigation on a clear night. Start as soon as the brighter stars in the sky are visible. Stand on a cemented floor—on the roof or a verandah and face towards the north.
- ❑ Use a compass needle to find the direction, if you are not sure.
- ❑ Find the Pole Star using the Ursa Major constellation.
- ❑ Point towards the Pole Star and let your helper mark out the direction of your hand on the floor with a piece of chalk. At the end of the line make a dot to show the position of the star.
- ❑ Now look in a different direction. Find two other bright stars about which you are sure you will be able to locate later also. Point towards them one by one, and let your friend mark the direction of your hand on the floor in both the cases. Mark the position of the stars with dot beside the three marks and write the time of observation.
- ❑ Go out after every hour and mark out the directions and positions of the three stars each time. Write the time of the observation next to each mark.
- ❑ How do the positions of the three stars change? In which direction do they move? Consult a science encyclopedia or a book on astronomy to find an explanation for your observations.



Formative Assessment - IV (Based on Units 13-15)

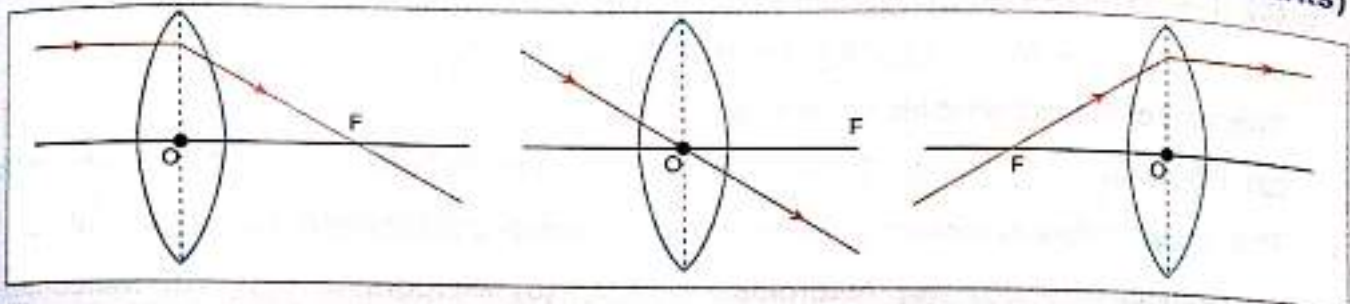
Max. Marks: 25

Time: 30 minutes
(12 Marks)

A. Short - answer Questions

1. Give a scientific reason of the fact that water is optically denser than air.
2. Explain briefly how we can intensify a magnetic field.
3. What is the difference between gangue and ore?
4. Explain the difference between a meteor and a meteorite.
5. A concave lens always forms a virtual image. Give a scientific reason for this.
6. Explain what you understand by the term 'angle of dip'.

B. Identify the rays of light shown in the following diagrams and also explain their paths. (04 Marks)



C. Group Activity

(02 Marks)

Visit the science laboratory and conduct an experiment to observe magnetic induction.

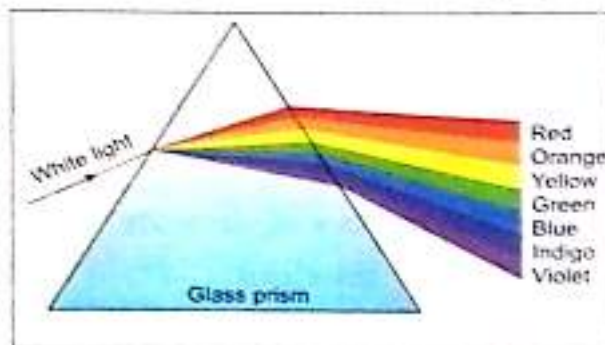
D. Give one - word answers of the following questions:

(04 Marks)

1. Who recorded the properties of magnets for the first time?
2. Name the branch of science which deals with the study of heavenly bodies.

Section B
(Structured Questions)

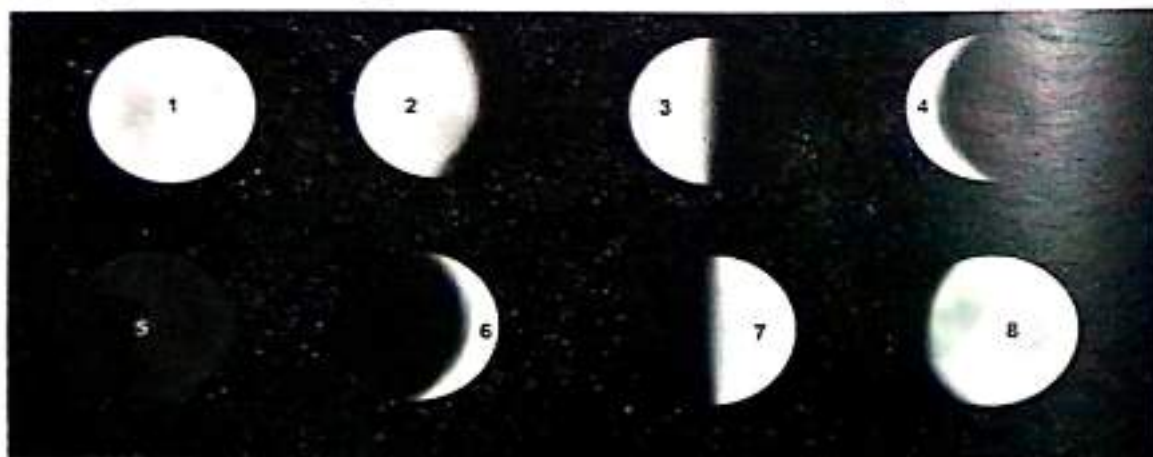
1. The following diagram shows an experiment related to properties of light. (04 Marks)



(a) Name the process which is discovered in this process. _____

(b) Briefly explain the working of experiment in the given space.

2. Identify the phases of moon given below and write them in the given space. (04 Marks)





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